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Liver Resection

1 *VEGF AS A POTENT STIMULATOR OF LIVER REGENERATION AFTER PARTIAL HEPATECTOMY*

Bockhorn M[1], Prokofiev D[1], Dammann P[1], Goralski M[1], Grünewald P[2], Schlaak J[2], Frilling A[1], Broelsch CE[1], (1) Department of General Surgery and Transplantation Surgery; (2) Department of Gastroenterology and Hepatology, University Hospital Essen, Essen, Germany

INTRODUCTION AND AIM: Angiogenesis is essential for the regeneration of the liver and vascular endothelial growth factor (VEGF) is one of the most potent angiogenic factors. The aims of the study were to determine the effects of exogenous VEGF administration in rats after two-thirds hepatectomy (PH) on angiogenesis, regeneration and expression of angiogenic genes. PATIENTS AND METHODS: Lewis rats ($n=5$/group) were subjected to PH. Group A (VEGF), group B (anti-VEGF), and group C (Control) were administered VEGF (100 ng/µl), anti-VEGF (4 µg/µl) or NaCl i.v. at 0 h, 36 h, and 96 h. At 0 h, 24 h, 48 h, 72 h, 120 h, 168 h, 5 rats each underwent intravital microscopy of the exposed liver remnant. Recorded parameters were: vessel density (VD), vessel diameter (VDi) and vessel flow (VF). Liver regeneration was monitored by measuring liver body weight ratio (LBR) and by Ki-67. Angiogenic gene expression profiles were determined by an inhouse cDNA macroarry including 70 genes involved in liver regeneration. RESULTS: In group A, VD was significantly increased compared with group B or C ($p<0.05$). VDi was also significantly increased through 24–72 h in group A ($p<0.05$). Group A had a significantly higher LBR after 48 h, 72 h and 120 h ($p<0.025$). PCNA immunostaining showed a significantly higher labelling index of hepatocytes at 24 h after PH with 82% compared with the control groups (3%). cDNA macroarrays showed a complex modulation of genes involved in liver regeneration. CONCLUSION: Exogenous VEGF administration leads to increased angiogenesis, which subsequently results in faster liver regeneration. VEGF treatment may provide a novel strategy for optimization of liver regeneration in patients after PH.

2 *ANATOMICAL AND PHYSIOLOGICAL CLASSIFICATION OF HEPATIC VEIN DOMINANCE APPLIED TO LIVER TRANSPLANTATION*

Radtke A[1], Malago M[1], Sotiropoulos G[1], Paul A[1], Lang H[1], Frilling A[1], Peitgen H[3], Schroeder T[2], Broelsch C[1], (1) General Surgery and Transplantation, University Hospital Essen; (2) Diagnostic and Interventional Radiology, University Hospital Essen, Essen, Germany; (3) MeVis-Center for Medical Diagnostic Systems and Visualisation, University of Bremen, Bremen, Germany

INTRODUCTION AND AIM: The hepatic vein dominance relationship needs meticulous attention and constitutes one of the main targets in preoperative planning. The aim of this study was to provide an anatomic-physiological classification of the hepatic vein dominance, that could be useful for surgical decision making in both donor and recipient. PATIENTS AND METHODS: 3-Dimensional CT imaging reconstructions obtained from 55 potential live liver donors evaluated between January 2003 and May 2004 at our Institution were analysed. RESULTS: The MHV and LHV show a relative lack of anatomical diversity, whereas the RHV exhibits multiple variants. 25 of 55 (45%) donors had inferior hepatic veins (IHV) with relevant venous drainage territory. Livers with IHV in which there was no RHV were not encountered. The RHV is predominantly dominant when present as a single vein without anatomical IHV (type 1A), or when considered as a complex with IHV (type 1Bx) (80% vs 88%). Only 55% of dominant type 1Bx RHV/IHV-complex automatically included a dominant type 1By RHV by itself. A single RHV out of anatomical complex with IHV (type 1By) was dominant in only 48% of our donor candidates. The MHV types 2A and 2By are strongly dominant, accounting for up to 57% of total liver volume (TLV). Only 1 of 55 (1.8%) donors had a dominant type 3Bx LHV. CONCLUSION: The proposed classification model including both anatomical and physiological attributes enables determination of venous dominance by taking into consideration the individual anatomical variability. The new nomenclature is universally applicable to the preoperative planing for LDLT.

3 *ALKALINE PHOSPHATASE ATTENUATES LIVER AND LUNG DAMAGE IN A MODEL OF ISCHEMIA-REPERFUSION WITH PARTIAL HEPATECTOMY IN RATS*

van Veen SQ, van Vliet AK, Dinant S, van Gulik TM, Department of Surgery (Surgical Laboratory), Academic Medical Center, University of Amsterdam, Amsterdam, The Netherlands

INTRODUCTION AND AIM: Endotoxin (lipopolysaccharide, LPS) mediates organ damage in liver and lungs in liver ischemia-reperfusion (I/R) and partial hepatectomy (PHX). Alkaline phosphatase (BIAP) dephosphorylates LPS into non-toxic monophosphate-LPS. This study determined the effects of BIAP on (LPS-mediated) liver and lung damage in a rat model of liver I/R with PHX. PATIENTS AND METHODS: Male Wistar rats were subjected to 70% liver I/R with or without PHX of all non-ischemic lobes (30%) during ischemia, or to PHX only, or sham operation. Single dose BIAP (0.5 IU/g body weight) or an equal volume of saline was given intravenously 5 min before reperfusion. After 24 h rats were sacrificed and blood, liver and lungs were collected. Parameters assessed were plasma AST and ALT, wet/dry ratio (a measure for tissue water content), myeloperoxidase (MPO, a measure for neutrophil activation), and histopathology of both liver and lungs. RESULTS: I/R increased hepatic and pulmonary wet/dry ratios, MPO activity and histology scores, which were reduced after BIAP treatment ($p<0.05$ vs saline), without an effect on transaminase activity in plasma. However, in the I/R-PHX groups, BIAP treatment reduced plasma AST and ALT, as well as improved wet/dry ratio and histopathology scores of the liver and decreased MPO activity (all $p<0.05$ vs saline). In the lungs, BIAP treatment reduced histopathology scores after I/R-PHX, without an effect on wet/dry ratio or MPO activity. CONCLUSION: BIAP reduced liver and lung injury after liver I/R, whereas after liver I/R-PHX, BIAP attenuated hepatocellular damage as well as inflammation, and improved pulmonary histology.

4 *IMPACT OF COMPUTER-ASSISTED RISK ANALYSIS ON OPERATION PLANNING IN MAJOR HEPATECTOMY*

Lang H[3], Hindennach M[1], Peitgen HO[1], Schroeder T[2], Radtke A[3], Broelsch CE[3], (1) MeVis-Center for Medical Diagnostic Systems, University of Bremen, Bremen, Germany; (2) Institut für Diagnostische und Interventionelle Radiologie, Universitätsklinikum Essen; (3) Klinik für Allgemein- und Transplantationschirurgie, Universitätsklinikum Essen, Essen, Germany

INTRODUCTION AND AIM: Standard planning of hepatic resection is based on two-dimensional (2-D) imaging of the liver. Recent developments in CT techniques allow an improved visualization of the distribution of intrahepatic vascular branches and a precise calculation of their depending territories. We evaluated the impact of computer-assisted risk analysis on operation planning in major hepatectomy. PATIENTS AND METHODS: In 25 patients, operation planning and measurement of the future liver remnant was performed at 2-D CT. Thereafter, calculation of the volume of the remaining liver tissue was repeated with a computer-assisted risk analysis. This volume was defined as the amount of tissue not being devascularized, but having portal venous blood supply and hepatic venous drainage after resection. The results of remaining liver tissue in 2-D CT and after computer-assisted risk analysis were compared. RESULTS: The deviation of 2-D CT and computer-assisted risk analysis was below 20% ($n=17/25$), between 20 and 30% ($n=4/25$), and between 30 and 40% and 40–50% in two patients, each. Most extensive deviations were found in extended left hepatectomy or when left hepatectomy was combined with an additional wedge resection in the right lobe. In 8 patients, the results of computer-assisted risk analysis led to a change of operation planning with regard to extend of resection or need for vascular reconstruction. CONCLUSION: By use of computer-assisted risk analysis areas at

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risk for devascularization can be calculated precisely prior to liver resection. In selected cases, particularly in small liver remnants or marginal hepatic function, operation planning may be improved substantially by this technique.

5 *HYPOTHERMIC PERFUSION OF PORCINE LIVER UNDER TOTAL VASCULAR EXCLUSION. THE EFFECT OF DIFFERENT TEMPERATURES AND PERFUSION SOLUTIONS*

Dinant S, van Veen SQ, Roseboom HJ, van Vliet AK, van Gulik TM, Surgical Laboratory, Academic Medical Center, Amsterdam, The Netherlands

INTRODUCTION AND AIM: Hypothermic *in situ* perfusion (HP) of the liver during total vascular exclusion (TVE) potentially reduces ischemia/reperfusion injury. The aim of this study was to investigate the effect of HP with two different temperatures and two different perfusion solutions on liver ischemia/reperfusion injury. PATIENTS AND METHODS: TVE was induced in 26 male pigs (40–50 kg) for 60 minutes. The portal vein was used to perfuse the liver during TVE. Pigs were divided into 4 groups: group 1 (no HP, $n=9$), group 2 (HP at 28°C with Ringerlactate, $n=6$), group 3 (HP at 20°C with Ringerlactate, $n=6$) and group 4 (HP at 28°C with Celsior solution, $n=5$). AST, interleukin-6 (IL-6) and histopathology score were measured together with indocyanine green (ICG) and hyaluronic acid (HA) clearance for liver function. RESULTS: Only in group 1, 3 pigs (33%) died shortly after TVE due to irreversible shock. AST (U/L) values 24 h after TVE were 1172 ± 440, 223 ± 69*, 180 ± 22* and 221 ± 49* in groups 1 to 4, respectively (mean $\pm$ SEM, *$p<0.05$ vs group 1). ICG clearance (% at 15 min after bolus injection) 6 h after TVE was 77 ± 5 in group 1 compared with 89 ± 2*, 90 ± 2* and 87 ± 3 in group 2, 3 and 4, respectively (*$p<0.05$). Histopathology score, IL-6 and HA clearance also showed benefits of HP, but no significant differences between HP groups. CONCLUSION: Maintaining core liver temperature at 28°C or 20°C equally reduces liver damage and preserves liver function during TVE. HP with Celsior solution has no advantage above HP with Ringer lactate.

6 *SURGERY PLUS INTRAOPERATIVE RADIATION THERAPY (IORT) FOR HILAR CHOLANGIOCARCINOMA*

Lang H[1], Kaiser G[1], Heuer M[1], Frühauf NR[1], Sauerwein W[2], Paul A[1], Malagó M[1], Broelsch CE[1], (1) Klinik für Allgemein- und Transplantationschirurgie; (2) Klinik für Strahlentherapie, Universitätsklinikum Essen, Essen, Germany

INTRODUCTION AND AIM: Despite advances in surgical therapy the prognosis of patients with hilar cholangiocarcinoma (Klatskin tumor) is still poor. Due to the often very small safety margins locoregional tumor recurrence is frequent. Intraoperative radiation therapy (IORT) is an attractive method for local application of a high energy dose in order to improve local tumor control. However, so far there is only little experience with IORT in the treatment of hilar cholangiocarcinoma. PATIENTS AND METHODS: The charts of 151 patients undergoing surgical exploration for hilar cholangiocarcinoma were reviewed. Tumor resection was performed in 82 cases. In 69 patients only an explorative or palliative approach was possible. IORT was added in 14 patients after tumor resection and in 15 patients after palliative surgery with a maximum dosage of 20 Gy. RESULTS: Postoperative complications were comparable after liver resections plus IORT versus liver resection. Median follow-up after liver resection is currently 19 months. Overall survival is 76% at 1 year and 42% at 3 years. So far, there is no significant difference in survival between surgery plus IORT versus surgery alone. CONCLUSION: Our results suggest that application of intraoperative radition therapy is not associated with an increased risk of postoperative complications. However, it remains undetermined whether IORT has a beneficial effect after potentially curative resection. Prospective randomized trials are required to clarify whether IORT leads to an improvement of the prognosis after radical surgery for hilar cholangiocarcinoma.

7 *CONSERVATIVE BUT RADICAL LIVER SURGERY: THE ROLE OF INTRAOPERATIVE ULTRASONOGRAPHY*

Torzilli G, Donadon M, Del Fabbro D, Palmisano A, Panizzo V, Montorsi M, 3rd Dept. of Surgery, Istituto Clinico Humanitas, Rozzano – Milan, Italy

INTRODUCTION AND AIM: Major hepatectomies are associated with higher blood loss, morbidity and mortality. However, the rate of major resection is still high in most surgical series. To verify whether intraoperative ultrasonography (IOUS) can minimize the rate of major hepatectomies we have prospectively evaluated our policy based on the extensive use of IOUS resection guidance. PATIENTS AND METHODS: Eighty-nine consecutive patients with liver tumors were prospectively enrolled. Fifty-one patients had HCC, 29 colorectal cancer liver metastases, 1 a mass-forming-type cholangiocarcinoma and 9 other metastatic tumors. Mean tumor size was 4.8 cm (median 4; range 1.1–28) and number was 2 (median 1; range 1–8). IOUS guidance was used for tumor staging and resection guidance in all patients. RESULTS: There was no postoperative mortality (at 30 days or during hospital stay) and major morbidity was 1.1%. Minor complications occurred in 11% of patients. Five (6%) patients required blood transfusion. Major resections (>2 segments) were accomplished in 14 patients (16%) and only 5 patients had more than 3 segments removed (6%). Forty patients had tumors located adjacent to the cavo-hepatic intersection (45%), and major vascular invasion was present in 34 patients (38%). Tumor clearance was achieved in all cases without local recurrence at 14 months of mean follow-up (median 10; range 1–39). CONCLUSION: This study shows that liver surgery performed under IOUS guidance is safe and radical, reducing the need for major hepatectomies even in the case of aggressive procedures for liver tumors located at the cavo-hepatic intersection or with vascular invasion.

8 *DUCT-TO-DUCT BILIARY ANASTOMOSIS IN LIVING-RELATED LIVER TRANSPLANTATION*

Dalgic A[3], Emiroglu R[1], Sozen H[1], Noyan T[1], Boyvat F[2], Tutar N[2], Haberal M[1], (1) General Surgery, Baskent University Faculty of Medicine; (2) Radiology, Baskent University Faculty of Medicine; (3) Department of General Surgery Division of Transplantation, General Surgery, Ankara, Turkey

INTRODUCTION AND AIM: Biliary duct-to-duct anastomosis in living-related liver transplantation for both adult and pediatric recipients has recently been used in our center. We described our technique and early results of patients who underwent living-related liver transplantation with duct-to-duct anastomosis. PATIENTS AND METHODS: Between January 2003 and July 2004, 34 patients underwent liver transplantation, giving 88.2% patient and graft survival, in our center. 23 of 34 recipients (7 adult and 16 pediatric, 67.6%) underwent living-related liver transplantation (LRLT) with duct-to-duct anastomosis with tube drainage technique. During recipient hepatectomy, the common bile duct was dissected and cut at the level of left and right hepatic bifurcation into the liver. A modified parachute technique with 7/0 polypropylene monofilament non-absorbable suture was used for anastomosis. In eight recipients (34.8%), T-tube and in 15 recipients (65.%), straight feeding tube were used for external drainage, which inserted from the recipient common bile duct. In the last two cases we abandoned the external drainage. All straight feeding tube drains were fixed to the insertion point of the recipient common bile duct and to the second portion of duedonum with cat-gut suture. All biliary drains were removed in third post transplantation month unless there were catheter-related complications or dislocation. RESULTS: Four patients died in the follow-up period (two ARDS and two viral sepsis). Of 34 patients, 30 (88.2%) were doing well with optimal liver function in the early post transplantation period. In 23 LRLT patients with duct-to-duct anastomosis, only 3 patients had a diagnosed anastomotic leak (13.0%). However, we observed short-term bile leak in 6 patients (3 patients developed bile leak from graft cutting surface, 2 patients had bile leak from tube insertion point) which were all treated conservatively. One patient's bile duct anastomosis was seperated during his T-tube removal, which was treated conservatively with percutaneous bile drainage. All 3 patients with anastomotic leak were also treated conservatively, with excellent results. There was no reoperation or long-term morbidity because of bile complications in our recipients. CONCLUSION: According to our early results, giving 88.2% graft and patient survival rates without major complication, we consider duct-to-duct anastomosis technique in partial or whole graft liver transplantation, when there is no tension effected to the anastomosis. Otherwise Roux-en-Y hepatico-jejunostomy should be performed to decrease the risk of biliary complications. With increasing experience in selected cases external drainage can be omitted.

9 LIVER RESECTION FOR HEPATOCELLULAR CARCINOMA IN PATIENTS UNDERGOING RENAL TRANSPLANTATION

Cheng SB[1], Wu CC[1], Ho WL[2], Hsu KS[3], (1) Surgery; (2) Pathology; (3) Nephrology, Taichung Veterans General Hospital, Taichung, Taiwan

INTRODUCTION AND AIM: Malignant disease is a major cause of late death after renal transplantation. Among them, hepatocellular carcinoma (HCC) is one of the most well-known malignancies after renal transplantation. Although liver resection remains the main option to cure HCC this study evaluated the role of liver resection in HCC patients undergoing renal transplantation. PATIENTS AND METHODS: A retrospective review of HCC patients who underwent liver resection between 1990 and 2003 was performed. A total 18 patients who received renal transplantation underwent liver resection for HCC (group 1). The clinicopathological characteristics early and long-term results of the other 634 HCC patients (group 2) were compared. RESULTS: There were no significant differences in patients' backgrounds, tumor pathological characteristics, postoperative morbidity and mortality. One (6.3%) patient in group 1 died after liver resection. Of the 17 survivors, 2 patients lost their graft kidney 3 and 5 years after liver resection and required hemodialysis. The 5-year disease-free and actuarial survival rates between group 1 and 2 were also not statistically different. CONCLUSION: Liver resection for HCC is still advocated in patients who have undergone renal transplantation. However, after operation, the graft kidney function should be under strict surveillance to maintain the long-term graft survival.

10 HEPATIC TISSUE CARBON DIOXIDE AND THE PRINGLE MANOEUVRE

Hammond JS[1], Brooks A[1], Ahmed I[1], Lobo D[1], Girling K[2], Beckingham I[1], (1) Surgery; (2) Critical Care, University Hospital Nottingham, Nottingham, UK

INTRODUCTION AND AIM: The optimal duration of hepatic portal inflow clamp and release during liver resection is not defined. Liver tissue carbon dioxide partial pressure (PtCO2) increases significantly following this manoeuvre and studies in animals have shown that this may result in liver cell death. The aim was to compare the PtCO2 following 10-min and 20-min portal inflow occlusion and determine the recovery after 10-min reperfusion. PATIENTS AND METHODS: PtCO2 was measured as described previously using a Paratrend multi-parameter sensor in 13 patients undergoing liver resection. Pringle manoeuvre was performed for 10 min in group 1 ($n=6$) and 20 min in group 2 ($n=7$). PtCO2 was recorded at 1-min intervals from application of clamp until recovery to baseline or 10 min of reperfusion. RESULTS: Pre-clamp median PtCO2 was 7.3 (IQR 6.4–10.3) kPa in group 1 and 7.2 (6.7–9.8) in group 2 ($p=0.95$). At the end of the clamp period PtCO2 increased significantly in both group 1, 11.5 (9.3–18) kPa, $p=0.041$ and group 2, 19.2 (15.7–26.6) kPa, $p<0.001$. PtCO2 was significantly greater in group 2 than group 1 ($p=0.035$). Following 5 min reperfusion baseline PtCO2 values were reached in group 1, but remained significantly raised in group 2, 12.9 kPa, $p=0.007$. In group 2 baseline values were reached in only 2 of 7 patients after 10 min of reperfusion. CONCLUSION: PtCO2 is increased significantly after both 10- and 20-min Pringle manoeuvres. Reperfusion of 5 min is adequate to restore baseline function after a 10-min clamp but this needs to be greater than 10 min following a 20-min clamp.

11 COMPLETE VERSUS SELECTIVE PORTAL TRIAD CLAMPING FOR MINOR LIVER RESECTIONS. A PROSPECTIVE RANDOMIZED TRIAL

Llado L[1], Figueras J[1], Ruiz D[1], Ramos E[1], Torras J[1], Montserrat A[1], Dalmau A[2], Miro M[2], Rafecas A[2], (1) Department of Surgery; (2) Department of Anesthesiology, Hospital Universitario de Bellvitge, Barcelona, Spain

INTRODUCTION AND AIM: Inflow occlusion can reduce blood loss during hepatectomy. However, the Pringle maneuver produces ischemic injury. Selective hemihepatic vascular occlusion techniques can reduce the severity of visceral congestion and total liver ischemia. The aim of this study was to evaluate feasibility, safety, efficacy, postoperative complications, and ischemic injury of selective clamping in patients undergoing minor liver resections. PATIENTS AND METHODS: Eighty patients undergoing minor hepatic resection were randomly assigned to complete clamping (CC) or selective clamping (SC). Hemodynamic parameters, the amount of blood loss, measurements of liver enzymes ALT, AST and postoperative evolution were also recorded. RESULTS: No differences were observed in the amount of hemorrhage (671 ± 533 ml vs 735 ± 397 ml; $p=0.54$) or the patients that required transfusion (10% vs 15%; $p=0.55$). There were no differences in postoperative morbidity between groups (38% vs. 29%; $p=0.38$). Cirrhotic patients with CC had significantly higher ALT (7.7 ± 4.6 vs 4.5 ± 2.7 mkat/L, $p=0.01$) and AST (10.2 ± 8.7 vs 4.9 ± 2.1 mkat/L; $p=0.03$) values on the first postoperative day than SC. The multivariate analysis demonstrated that high CVP, HVPG >10 mmHg and intraoperative blood loss were independent factors related to morbidity. CONCLUSION: Both techniques of clamping are equally effective and feasible for patients with normal liver undergoing minor hepatectomies. However, in cirrhotic patients selective clamping induces less ischemic injury and should be recommended. Finally, even for minor hepatic resections, central venous pressure, HVPG and intraoperative blood loss are factors related to morbidity and should be considered.

12 ASSESSMENT OF RISK FOR POSTOPERATIVE MORBIDITY AFTER MAJOR HEPATECTOMIES: ANALYSIS OF 133 CONSECUTIVE CASES

Iesalnieks I[2], Anthuber M[1], Agha A[2], Schlitt HJ[2], Piso P[2], (1) Surgery, Klinikum Augsburg, Augsburg, Germany; (2) Surgery, University of Regensburg, Regensburg, Germany

INTRODUCTION AND AIM: This retrospective study was performed to identify the risk factors for development of postoperative complications in patients after major hepatectomy. PATIENTS AND METHODS: A total of 133 patients underwent major hepatectomies, defined as a resection of 3 or more liver segments between 2/1992 and 6/2003. Fourteen patients underwent surgery because of benign disease, 119 patients because of malignant disease. The diagnoses included: colorectal metastases (60), hepatocellular carcinoma (18), intrahepatic cholangiocarcinoma (17), hilar cholangiocarcinoma (9), and other diseases (29). RESULTS: Types of hepatectomy were: right lobectomy (63), left lobectomy (55), resection of 3 liver segments (11), and central hepatectomy (4). The biliodigestive reconstruction was performed in 23 cases. The mean time of surgery was 252 min, the mean blood loss was 1656 ml. Intraoperative autologous blood transfusion was performed in 65 patients (49%). Morbidity was 47%, and mortality was 7.5%. The most frequent complications were: pleural effusions necessitating a drain (21%), biliary complications (16%), abscess (13%), and hepatic failure (10%). On multivariate analysis, right lobectomy, biliodigestive reconstruction, blood loss >1000 ml, and duration of surgery >250 min were the significant predictors of postoperative complications. These factors were used in a scoring system. The total score was highly predictive of postoperative morbidity ($p<0.0001$). CONCLUSION: There is a substantial risk of postoperative complications following major hepatectomies. Biliodigestive reconstruction, blood loss, and duration of surgery are independently associated with increased postoperative morbidity. Right lobectomy leads to increased frequency of pleural effusions. These variables can be included in a score for predicting postoperative complications.

13 MAJOR HEPATIC RESECTIONS TO TREAT COMMON BILE DUCT INJURY

Pekolj J, Quiñonez E, Palavecino M, Mazza O, Stork G, de Santibañes E, Hepato-Pancreato-Biliary Surgery and Liver Transplantation, Hospital Italiano, Buenos Aires, Argentina

INTRODUCTION AND AIM: Endoscopic, percutaneous and surgical procedures are used in the management of common bile duct injury (CBDI). Major hepatic resections (MHR) are not indicated frequently. The aim of this study is to analyze indications, outcomes, technical and tactical aspects of MHR to treat CBDI. PATIENTS AND METHODS: 166 patients with CBDI were treated between January 1988 and December 2003. 8 patients (4.8%) required MHR. 4 were men, mean age was 41.8 years (r: 6–62). 5 open surgeries and 3 laparoscopic surgeries were the causes of the CBDI. Arterial injury was associated in 37.5% and portal injury in 12.5%, all of them were

diagnosed by angiography. The period between the injury and the resection was 24 months (r: 2–407). Previous surgeries: 2.4 (r: 1–4). Clinical presentation: recurrent cholangitis in 6 patients. The indications to perform the hepatic resection were: 3 patients with intrahepatic strictures, 3 with unilateral stricture with bilio-digestive derivation (after failed percutaneous dilatation), 1 with complex CBDI, 1 with right hepatic artery injury, and 1 with a probable tumor. RESULTS: We performed 4 right hepatectomies and 4 left hepatectomies. The Pringle maneuver was used in 4 patients. Mean operative time was 305 minutes (r: 270–360). No patients needed red blood cell transfusions. Biliary reconstruction: in 6 hepatico-jejuostomy, and 1 bi-hepatico-jejunostomy. Morbidity was 37.5%. Mean follow-up 59.9 months (r: 3–129). CONCLUSION: Hepatic resection is a good treatment for complex CBDI (those associated with vascular injury and biliary confluence injury) followed by intrahepatic strictures and/or lobar atrophy. MHR are complex procedures because of hepatic pedicle sclerosis, adherences and atrophy-hypertrophy phenomenon.

14 *FIRST EXPERIENCE USING THE NEW COAGULATION DEVICE INLINE RESECT FOR LIVER RESECTION*

Pistorius GA, Lindemann W, Schilling MK, Hospital of Saarland, Clinic of General, Visceral, Vascular and Pediatric Surgery, Homburg/Saar, Germany

INTRODUCTION AND AIM: InLine Resect is a newly developed bipolar coagulation system to perform precoagulation of liver tissue before dissection. PATIENTS AND METHODS: From 05/2004 to 11/2004 the new bipolar coagulation device (InLine Resect) was used in 15 hepatic resection. 11 anatomical and 4 atypical resections were performed using Helix hydrojet or Ultrasound selector for dissection of liver tissue. The blood loss/cm^2 and the dissection time/cm^2 resection area were measured and compared to 25 hepatic resections using only hydrojet and to 26 patients using ultrasound selector. RESULTS: There was a reduction of blood loss from 28% and 17% in the mean (median blood loss InLine 4.1 ml/cm^2, Hydrojet 6.7 ml/cm^2, Ultrasound selector 5.4 ml/cm^2) and a reduction of resection time compared to the techniques without precoagulation. No bile leakage or bleeding was seen. CONCLUSION: The new bipolar precoagulating device seems to reduce blood loss and resection time in hepatic resections without increasing complication rate. An update will be given at presentation.

15 *SAFETY OF ISOLATED IVb (INFERIOR) RESECTION OF THE LIVER BY CADAVER DISSECTION*

Kim IG[1], Wang HJ[2], Park JW[2], Kim BW[2], Lee BH[1], Kim MW[2], (1) Department of Surgery, Hallym University College of Medicine, Chunchon, South Korea; (2) Department of Surgery, Ajou University School of Medicine, Suwon, South Korea

INTRODUCTION AND AIM: There have been many controversies in surgical anatomy of the liver until now. Segment IV of the liver lies between the main fissure on the right and the umbilical fissure on the left. Posteriorly, segment IV extends back and is separated from segment I by dorsal fissure. Healey and Schroy divided segment IV as "superior portion (IVa)" and "inferior portion (IVb)". Couinaud suggested that there was no useful purpose in dividing segment IV for several reasons. Our goal is to evaluate the safety of isolated IVb (inferior) resection of the liver by the dissection of the cadaver. PATIENTS AND METHODS: The number of cadavers was 10. Cadaver dissection was proceeded in respect of Glissonian pedicle at first. Then, it was performed in respect of portal vein and bile duct, respectively. The total number of Glissonian pedicles at segment IV was measured. The distance between the origins of IVa and IVb branches was measured. Additional pedicle was also evaluated that was known to exist at IVa. RESULTS: The total mean number of Glissonian pedicles in segment IV was 5 (1.3). The mean number of Glissonian pedicles at segment IVa was 1.6 (7). The mean number of Glissonian pedicles at segement IVb was 3.4 (0.9). Mean distance between the origins of IVa and IVb branches was 5.6 mm (3.9). Two of 10 cases had a very short distance between the origins to be considered as having common origin. An additional pedicle was identified at Lt. main Glissonian pedicle in all the cases (8 cases, 1 each; 2 cases, 2 each). CONCLUSION: Considering the possible existence of the common origin of the segment IVa and IVb Glissonian pedicle, there is a risk that segment IVa may be injured during isolated IVb resection. In isolated IVb resection, if discoloration of IVa after temporary clamping of the sizable Glissonian pedicle is observed, we should think that the pedicle has common origin of segment IVa and IVb. Inevitable ligation of the additional pedicle of IVa from Lt. main Glissonian pedicle can be made during isolated IVb resection. Therefore, we think that isolated IVb resection of the liver can be safe only when the surgeon divides the branches of segment IVb while preserving the IVa branches meticulously.

16 *HEPATECTOMY USING RADIOFREQUENCY ENERGY*

Felekouras E[1], Kontos M[1], Prassas E[1], Pikoulis E[1], Papakonstantinou I[1], Revenas K[2], Griniatsos I[1], Diamantis T[1], Bramis J[1], Papalambros E[1], Giannopoulos A[1], Bastounis E[1], (1) 1st Department of Surgery, University of Athens, Laiko General Hospital; (2) Department of Radiology, Laiko General Hospital, Athens, Greece

INTRODUCTION AND AIM: Radiofrequency energy is used in hepatobiliary surgery not only for tumor ablation but also in hepatectomies. The aim of this study is to present our experience in hepatectomies with the use of radiofrequency ablation (RFA) as the main tool for liver parenchymal dissection. PATIENTS AND METHODS: From June 2003 until October 2004, 24 RFA-assisted liver resections were performed in 21 patients. Twelve lobectomies, 7 segmentectomies and 5 wedge resections were performed using this technique. Indication for hepatectomy was hepatocellular carcinoma in 11 cases, cholangiocarcinoma in 2 and metastatic carcinoma in 8 patients (11 tumors). Eight patients were cirrhotics. We used RFA equipment with internally cooled tip electrodes (Radionics, Tyco Hellas, Athens, Greece) and no type of vascular occlusion was required. RESULTS: Mortality (30 days) was 0%. The morbidity rate was 19.04% (4/21). Four postoperative complications occurred in 4 patients (myocardial infarction, bile leakage, abscess and biloma formation). Nine patients were transfused during the peroperative period (mean 1.2 units). All tumors were excised with clear margins as was proven by histology of the resection and the remain liver margins. CONCLUSION: RFA-assisted liver resection is a safe surgical modality with an acceptable rate of postoperative complications and minimal mortality. This could be attributed to the minimal blood loss and low need for blood transfusions. Moreover, the avoidance of any type of vascular occlusion and the extended clear tumor margins resulted in very good early and hopefully better late results.

17 *POSTOPERATIVE LIVER FAILURE AND FUTURE LIVER REMNANT: WHICH IS THE LIMIT?*

Ferrero A[1], Viganò L[1], Muratore A[1], Polastri R[1], Lo Tesoriere R[1], Eminefendic H[2], Regge D[2], Capussotti L[1], (1) Surgery, Ospedale Mauriziano Umberto I; (2) Radiology, Institute for Cancer Research and Treatment, Torino, Italy

INTRODUCTION AND AIM: Indications for preoperative portal vein embolization (PVE) remain controversial. To identify the future liver remnant (FLR) limit for a safe major hepatectomy with a low risk of postoperative liver failure. PATIENTS AND METHODS: Between April 2000 and September 2004, 173 patients underwent major liver resection. FLR was calculated with CT-volumetry. Patients with FLR lower than 25% underwent PVE; in presence of liver cirrhosis FLR accepted was 30%. The 137 patients without preoperative PVE were divided into groups according to the estimated FLR: 25–30% (25 patients), 31–35% (22), 36–40% (15), 41–45% (23) and $>46\%$ (52). Postoperative blood tests and short-term results were analysed. Outcomes of patients with preoperative jaundice or aggressive neoadjuvant chemotherapy (Group A, 47 patients) were compared to the remaining patients (Group B, 90). RESULTS: Mean FLR was 46.1% (range 25–85%). Eight (5.8%) patients developed a postoperative liver failure: all these patients had a FLR lower than 35%. Patients with a FLR $<35\%$ had significantly worse liver function tests on postoperative day 3 and 7, but they presented similar clinical outcomes (mortality 2.1% vs 1.1%, morbidity 40.4% vs 28.9%, $p=$ns). Comparing group A and B, the incidence of postoperative liver failure was similar in the two groups (4/47 [8.5%] vs 4/90 [4.4%], $p+=0.56$); in group B, postoperative liver failure occurred only in patients with FLR $<30\%$. CONCLUSION: After major hepatectomy, no liver failure occurred in patients with FLR $>35\%$. Considering only patients without

preoperative jaundice or aggressive neoadjuvant chemotherapy, a safe FLR was 30%.

18 *EXTENDED HEPATECTOMY: RESULTS OF A SINGLE UK HEPATOBILIARY CENTRE*

Neal CP, Pattenden C, Mann C, Stephenson J, Garcea G, Dennison A, Berry D, Department of Hepatobiliary and Pancreatic Surgery, Leicester General Hospital, Leicester, UK

INTRODUCTION AND AIM: Extended hepatectomy represents the only potential cure for many patients with hepatobiliary malignancy. The aim of this study was to evaluate the results of extended hepatic resections in our centre. PATIENTS AND METHODS: Patients undergoing extended hepatectomy between 1996 and 2004 were identified from our Hepatobiliary Cancer database and notes reviewed by a single observer. RESULTS: Sixty-three patients were treated with extended hepatic resection, with 60 extended right hepatectomies and 3 extended left hepatectomies. Median patient age was 58 years (range 39–77 years). Underlying disease included colorectal metastases ($n=43$; 68%), cholangiocarcinoma ($n=10$; 16%), neuroendocrine malignancy ($n=4$; 6.3%), hepatoma ($n=1$; 2%) and benign disease ($n=2$; 3%). Ten patients had resection of additional hepatic tissue and 11 patients underwent a synchronous intra-abdominal procedure. Median operating time was 300 minutes (range 210–700 minutes), with 28 patients (44%) receiving intra-operative blood transfusion. Median hospital stay was 13.5 days (range 7–62 days), with an in-patient morbidity rate of 28.6%. 30-day mortality was 3.2% and 60-day mortality 6.3%, with all deaths occurring secondary to hepatorenal failure. CONCLUSION: Low operative morbidity and mortality justifies extended hepatic resection for hepatobiliary malignancy.

19 *FUTURE LIVER REMNANT: COMPARISON OF TWO MEASUREMENT TECHNIQUES*

Viganò L[1], Ferrero A[1], Muratore A[1], Polastri R[1], Eminefendic H[2], Vallefuoco D[1], Regge D[2], Capussotti L[1], (1) Surgery, Ospedale Mauriziano Umberto I; (2) Radiology, Institute for Cancer Research and Treatment, Torino, Italy

INTRODUCTION AND AIM: An adequate future liver remnant (FLR) reduces the risk of postoperative liver failure after major hepatectomy. The aim of this study was to compare two different FLR measurement techniques. PATIENTS AND METHODS: Between April 2000 and September 2004, 137 patients underwent major liver resection without preoperative portal vein embolization. Remnant liver volume was prospectively calculated with CT-volumetry. The first technique (FLR%) calculated the percentage of remnant liver with the formula: [FLR/(total liver volume − tumor volume)] × 100; the second technique (FLRW) used the formula: [FLR (ml)/ body weight (g)] × 100. Postoperative blood tests and short-term results, with special regard to liver failure, were analyzed according to calculated FLR. RESULTS: Mean FLR, FLR% and FLRW were 631 ml (range 227–1853 ml), 46.1% (25–85%) and 0.9% (0.35–2.25%), respectively. Results of the two techniques had a significant correlation ($p<0.0001$). Prothrombin time and bilirubin on postoperative day 3 and prothrombin time on day 7 significantly correlated with FLR calculated with both techniques. In-hospital stay, overall morbidity and mortality were not significantly related to FLR% or FLRW. Patients who developed a postoperative liver failure (8 patients, 5.8%) had a significantly lower FLR% (29.5% vs 47.2%, $p<0.003$) and FLRW (0.61% vs 0.92%, $p<0.022$). ROC curves evidenced a high predictivity of both measurement techniques for postoperative liver failure (area under curve 0.866 FLR% vs 0.779 FLRW). CONCLUSION: FLR calculated with both techniques significantly correlates to postoperative liver failure and postoperative bilirubin and prothrombin time.

20 *PROGNOSTIC SIGNIFICANCE OF NON-ALCOHOLIC STEATOHEPATITIS (NASH) AND INTRAHEPATIC INVASION IN PATIENTS UNDERGOING LIVER RESECTION FOR METASTATIC ADENOCARCINOMA*

Nisar PJ[2], Lobo DN[1], Zaitoun AM[1], Ethunandan M[1], Dowson CC[1], Ryder SD[2], Aithal GP[2], Doran J[1], Beckingham IJ[1], (1) Section of Surgery; (2) Department of Histopathology, University Hospital, Queen's Medical Centre, Nottingham, UK

INTRODUCTION AND AIM: To identify the association of clinicopathological factors with morbidity and survival in a cohort of patients undergoing liver resection for metastatic colorectal adenocarcinoma. PATIENTS AND METHODS: Data were collected retrospectively on 90 consecutive patients undergoing a potentially curative liver resection for metastatic colorectal adenocarcinoma between 1995 and 2000. Intrahepatic spread was classified as vascular, bile duct, perineural and lymphatic invasion. NASH scores were according to the 'Brunt' system. Primary endpoints were mean survival time and time to normalisation of bilirubin and ALT following resection. Analysis was performed using the log-rank and the Kruskal-Wallis tests. RESULTS: In the 90 liver resections, there were 2 perioperative deaths. The mean (SE) overall survival time in months for patients with single metastases was greater than for patients with multiple metastases 35.9 (5.1) vs 27.4 (3.8); patients with vascular invasion had shorter survival times, 35.6 (3.5) vs 40.3 (7.6); as did patients with lymphatic invasion 29.8 (4.2) vs 42.1 (4.5). These trends were not statistically significant. The mean (SE) time to normalisation of ALT in patients with no evidence of NASH or mild disease was 18.2 (2.9) days. In patients with moderate and severe NASH, times to normalisation of ALT were significantly raised: 24.2 (4.4) days and 58.9 (14.4) days respectively ($p=0.01$). CONCLUSION: The presence of moderate/severe NASH is associated with an increased risk of peri-operative morbidity as measured by liver enzymes after liver resection. A non-statistically significant reduction in survival is demonstrated in patients with lymphatic and vascular invasion and in liver resection for multiple metastases.

21 *SUCCESSFUL TREATMENT OF POST-RESECTION ACUTE LIVER FAILURE WITH PORTAL VEIN ARTERIALIZATION IN THE RAT*

Nardo B[1], Puviani L[1], Montalti R[1], Bertelli R[1], Beltempo P[1], Cavallari G[1], Pacilè V[1], Licursi M[1], Caraceni P[2], Pariali M[3], Cavallari A[1], (1) Department of Surgery and Transplantations; (2) Department of Internal Medicine, Cardioangiology and Hepatology; (3) Biomedical Research Center, S. Orsola Hospital, Bologna, Italy

INTRODUCTION AND AIM: Extended liver resection (ELR) may lead to acute liver failure (ALF) requiring liver transplantation. Thus, we aimed to determine whether the increase of oxygen supply after ELR by portal vein arterialization (PVA) is an effective treatment for post-resection ALF. PATIENTS AND METHODS: Post-resection ALF was induced in SD rats by 85% hepatectomy plus 15 min of warm ischemia. The rats were randomly divided into (1) ELR group, associated to left nephrectomy and splenectomy; (2) ELR + PVA group: an arterial-portal shunt by connecting left renal artery to splenic vein with a polyethylene stent following nephrectomy and splenectomy. The rats were sacrificed at 1, 2 and 10 days to collect serum and liver samples. Survival rates, liver regenerative rate (LRR), BrdU labelling index and levels of transaminases were assessed. RESULTS: Post-resection ALF was greatly reduced in the PVA group compared to not-PVA rats as indicated by the 10-day survival rate: 75% vs 16.6%, respectively. The liver regenerative rate (LRR) and BrdU labelling index were significantly increased by PVA within 2 days, but no differences were seen at 10 days. The 1- and 2-day serum transaminases levels were significantly lower in the PVA group compared to not-PVA group; no differences were observed at 10 days in the transaminases levels. CONCLUSION: This study indicates that likely increasing the supply of oxygen to the liver through the portal system promotes hepatocyte regeneration leading to a significant better survival in a ELR rat model. Thus, PVA may represent a novel, alternative approach for treatment of post-resection ALF.

22 *INFERIOR VENA CAVA RESECTION WITH OR WITHOUT GRAFT REPLACEMENT IN HPB SURGERY*

Vicente E[3], Quijano Y[1], Fernandez E[2], Monroy C[1], Loinaz C[1], Beni R[1], Prieto I[1], Bueno G[3], (1) General Surgery, Hospital Madrid MontePríncipe; (2) Urology Service, Hospital Ramón y Cajal; (3) General Surgery Department, Hospital Ramón y Cajal, Madrid, Spain

INTRODUCTION AND AIM: Due its proximity to a number of important regional vascular structures, tumors of the liver, biliary tract, pancreas, retroperitoneum area and kidney are often associated with regional invasion or compression of the inferior vena cava (IVC). We describe the personal experience and technical

considerations for inferior vena cava resection in selected cases of advanced tumors. PATIENTS AND METHODS: 12 patients required a concomitant resection of IVC with and without reconstruction in order to obtain a complete tumor resection with free margin. There were 5 males and 7 females; ages ranged from 32 to 54 years (mean age: 45 years). The primary disease was: liver metastasis from colon cancer (4), ruptured hydatid cyst into IVC with hydatid thrombus in IVC and atrium and pulmonary dissemination (2), intrahepatic cholangiocarcinoma (1), renal cancer + tumoral thrombus into IVC (2), tumoral thrombus into IVC (2) and tumoral thrombus into IVC + liver infiltration (segment V) (1). Total (3) and retrohepatic (3) IVC was performed in 6 patients. In 2 and 4 patients, we resected IVC with renal veins and hepatic vein bifurcation, respectively. Multivisceral resection was performed: Right hepatectomy extended to segment IV (4), hepatic segmentectomy (segment V) (1), total excision hydatid cyst (2)—one of them with IVC and atrium trombectomy, nephrectomy (3) and tumor thrombus resection (2). RESULTS: The general morbidity of the procedures was 29%, related to the vascular resection (8%). The early and late patency vascular reconstruction was 91%. 1 patient had a graft thrombosis after IVC resection and graft replacement. 1 patient died in the postoperative period due to liver failure. The 1-year survival was 100% for patients operated for liver metastasis and tumoral thrombus secondary to renal cancer, respectively. CONCLUSION: Our initial experience suggest that the IVC resection can be performed in selected cases with a low risk of morbidity and mortality. Long-term patients' outcome is not determined by the need to perform a concomitant vascular resection but rather by the biological behavior of the resected malignancy.

23 *EVALUATION OF PREDICTIVE FACTORS FOR POSTOPERATIVE OUTCOME IN PATIENTS AFTER LIVER RESECTION. A PROSPECTIVE STUDY IN 212 CONSECUTIVE PATIENTS*

Kraus A, Mc Cormack L, Selzner M, Furrer K, Clavien PA, Department of Visceral and Transplantation Surgery, University Hospital of Zürich, Zürich, Switzerland

INTRODUCTION AND AIM: To identify predictive factors for postoperative outcome in patients undergoing liver resection. For outcome measurement, a new classification system was used. PATIENTS AND METHODS: A prospective database containing 212 consecutive patients was evaluated and 3 different parameters measuring postoperative outcome were defined: (1) postoperative AST for liver cell necrosis; (2) serum creatinine for postoperative renal function; (3) a new complication score with grades 0 (no complication), I (no treatment) II (pharmacological treatment), III (surgical, endoscopic or radiological intervention), IV (life-threatening) and V (death). RESULTS: Liver cell necrosis significantly correlated with preoperative AST, operation time, ischemia time, intraoperative blood loss and malignancy. Postoperative kidney function significantly correlated with patient age, intraoperative blood loss, preoperative serum creatinine, male sex and cirrhosis. In multivariate analysis operation time, ischemia time, preoperative AST, malignancy and preoperative thromboplastin time were predictive for postoperative liver function, ischemia time being most important. Patient age, preoperative creatinine and intraoperative blood loss were predictive for postoperative kidney function. For complications blood loss, preoperative bilirubin and operation time were predictive. CONCLUSION: Patient age, preoperative creatinine and intraoperative blood loss predict postoperative kidney function. Ischemia time influences postoperative liver function. Assessing blood loss, bilirubin before surgery and operation time can be helpful to predict complication rates after liver resection.

24 *RESECTION OF HEPATOCELLULAR CARCINOMA WITH PORTAL VEIN TUMOUR THROMBUS Vp4: A REPORT OF TWO CASES*

Yamamoto J, Nagai M, Ohmori T, Tamaki S, Kubota T, Sasaki K, Uchino M, Surgery, Chibanishi General Hospital, Chiba, Japan

INTRODUCTION AND AIM: The prognosis of far advanced hepatocellular carcinoma (HCC) with portal vein tumor thrombus (PVTT) is extremely poor. The development of tumor thrombus in the main portal vein trunk is considered to be the terminal stage of this disease process and is associated with rupture of esophageal varices or hepatic failure. We have experienced two cases of HCC with PVTT in the main portal vein trunk and the side of the portal branch (Vp4). Herein we show our technique for surgery and discuss the indication of the surgery for these cases. PATIENTS AND METHODS: Case 1. 60-year-old Japanese male, with a tumor occupying S7 and S8 subsegments of the liver. PVTT was observed originating from the right branch of the portal vein and extended to the main and left side. A right hepatectomy and removal of the tumor thrombus was performed. To reduce the bleeding from collateral veins, we inserted a bypass tube between the superior mesenteric vein and falciform ligament. We used color Doppler ultrasonography intra-operatively following removal of involved segment. Case 2. 59-year-old Japanese male with HCC occupying the lateral and median segment of the liver. PVTT was observed originating from the left branch of the portal vein and extending to the main and right side. A left hepatectomy with removal of the PVTT was performed. To avoid a massive hemorrhage during the removal of portal vein tumor thrombus, we inserted a bypass tube between the superior mesenteric vein and great saphenus vein. The patient recovered after initial surgery without any complication. One month after surgery, follow-up percutaneous Doppler ultrasound of the portal vein showed good blood flow without compromise. RESULTS: Case 1. Approximately 1 month after surgery the patient presented with recurrence of PVTT in the main portal trunk and superior mesenteric vein. Intrahepatic arterial infusion of 5-fluorouracil with interferon beta was performed. The patient died of liver failure secondary to multiple intrahepatic metastasis 6 months postoperatively. Case 2. One month after surgery, follow-up percutaneous Doppler ultrasound of the portal vein showed good blood flow without compromise. However, approximately 2 months postoperatively, the patient had progressive development of hepatic coma. Enhanced computed tomography revealed no blood flow in the portal vein without hypertrophic changes in the residual liver. CONCLUSION: Although we performed complete removal at the time of initial surgery, our two patients had tumor recurrences in the portal vein. To expect better prognosis of patients with HCC Vp4, we need to utilize other effective surgical or non-surgical methods. Furthermore, investigations are needed to evaluate these techniques and study their benefits.

25 *RESCUE HEPATIC RESECTION FOR RECURRENT LIVER MALIGNACIES AFTER PERCUTANEOUS LOCAL ABLATION THERAPY*

Maeda A[1], Uesaka K[1], Matsunaga K[1], Kanemoto H[1], Furukawa H[2], Morimoto N[2], (1) Hepato-Biliary-Pancreatic Surgery; (2) Diagnostic Radiology, Shizuoka Cancer Centre Hospital, Shizuoka, Sunto-Nagaizumi, Japan

INTRODUCTION AND AIM: To assess clinical significance of 'rescue' hepatic resection for recurrent malignant tumors treated initially by percutaneous local ablation; e.g. radiofrequency ablation (RFA), microwave coagulation (MCT), and ethanol injection (EI). PATIENTS AND METHODS: Between September 2002 and October 2004, 148 patients underwent hepatectomy for hepatocellular carcinomas (HCC) and metastatic tumors at the authors' institute. Among them, 15 (10.1%) were initially treated by percutaneous local ablation. Patients' demographics, indications for surgery, and outcomes were analyzed. Our inclusion criteria were the same as those for untreated patients. RESULTS: The study group consisted of 10 patients with HCC and 5 with metastatic tumors. Indications for conversion to surgery were uncontrollable tumor size in 10 patients, ill location in 3, vascular involvement in 1, and extrahepatic lesion in 1. Previous interventions in 14 patients were performed in other hospitals and referred to us for further treatment. In 15 patients, 12 sessions of RFA, 4 MCT, and 4 EI were performed. Major hepatectomies (>3 segments) were performed in 8. Thirteen patients underwent curative resection and two required transarterial embolization for remaining small tumors. Median follow-up time was 13 (2–24) months. Two patients died of primary disease (24 and 6 months, respectively), 5 are still alive with recurrence, and 8 remained alive without recurrence with median survival time of 13 (2–24) months. The morbidity rate was 26% and no hospital deaths were observed. CONCLUSION: "Rescue" liver resection may be a choice of treatment for recurrent hepatic malignancies after percutaneous ablation therapy in selected patients.

26 RISK OF ELECTIVE RIGHT HEPATECTOMY FOR TUMOURS IN PATIENTS WITH NORMAL LIVER

Stenard F, Dondéro F, Balzan S, Sommacale D, Sauvanet A, Belghiti J, Digestive Surgery, Hospital Beaujon, Clichy, France

INTRODUCTION AND AIM: Surveys concerning the donor's risk after right hepatectomy (RH) have been collected in Europe since 1998. The lack of comparative reference led us to present data concerning the risk of elective RH for liver tumors in patients with normal liver resected during the same period. PATIENTS AND METHODS: From 1998 to 2003, 176 patients with malignant ($n=137$) and benign ($n=39$) tumours arising in normal liver underwent an elective RH through exclusive abdominal incision. RESULTS: The mean duration of the procedure was 318 ± 99min (150–720), with intermittent pedicle clamping in 107 (60%) for a mean duration of 35 ± 30min. The rate of transfusion was 28% ($n=49$). One (0.6%) patient, aged 52 years, died postoperatively after resection of HCC with a small remnant liver (<30% of total liver volume). The 9 (5%) patients who experienced transient post-operative liver failure were resected for malignant tumours. The overall morbidity rate was 28% ($n=49$) including, biliary leak in 9 (5%), abdominal collection in 15 (9%) and pulmonary complications in 41 (23%). Reoperation was required in two (1.1%) patients for wound haemorrhage and haemorrhagic gastric ulcer. The mean hospital stay was 16 ± 11days. CONCLUSION: Results of this study allow us to declare a 0.6% rate of mortality and 28% rate of morbidity after elective right hepatectomy in patients with normal liver. Further comparative studies should determine if this assertion remains valuable for right liver donors.

27 INTRA-OPERATIVE LIVER INJURY IS NOT ONLY RELATED TO VASCULAR CLAMPING

Boschetto A, Dondero F, Tonini V, Balzan S, Sommacale D, Farges O, Sauvanet A, Belghiti J, Digestive Surgery, Beaujon Hospital Paris University 7, Clichy, France

INTRODUCTION AND AIM: It is widely accepted that during liver resections parenchymal ischemia is induced by vascular clamping and assessed on days 1 and 2 by the postoperative increase of serum transaminase level (ALT). This prospective study aimed to identify early changes in ALT level during resection. PATIENTS AND METHODS: From June 2003, 52 patients (aged 53 ± 14 years) with an elective right hepatectomy, including 42 with intermittent clamping for a mean duration of 37 min (range 15–64), were included. Blood samples were collected during operation (before incision, before liver transection and before abdominal closure) and postoperatively, on days 1, 2, 5 and 7. RESULTS: During operation mean ALT level was 30 ± 10 before incision; 144 ± 116 before transection and 273 ± 187 before abdominal closure. ALT level before abdominal closure was not statistically different in the groups with or without clamping (273 ± 187 vs 275 ± 198). Postoperative mean ALT level was 318 ± 140 on day 1 and 249 ± 137 on day 2 without significant difference according to the presence or not of clamping (326 ± 148 vs 286 ± 100 on day 1 and 258 ± 148 vs 215 ± 69). The mean ALT level before abdominal closure reflected the mean ALT level on day 1 (273 ± 187 vs 318 ± 140). CONCLUSION: During liver resection, the ALT level started to increase early, before parenchymal transection and was not affected by the presence of clamping. The peak of ALT level, which can be anticipated at the end of the procedure, seems to be related to factors other than ischemia-reperfusion injury.

28 VENOUS AND ARTERIAL RESECTION IN HPB SURGERY

Vicente E[2], Quijano Y[1], Loinaz C[1], Monroy C[1], Prieto I[1], Beni R[2], Garcia-Moreno F[2], Bueno G[2], (1) General Surgery, Hospital Madrid MontePríncipe, General Surgery Department; (2) Hospital Ramón y Cajal, General Surgery Department, Madrid, Spain

INTRODUCTION AND AIM: Vascular resection for cases of advanced tumors remains controversial, because of the high risk of postoperative complications and extremely poor long-term survival. Recent advances in surgical technique have contributed to an increased resectability rate and to an improved prognosis and outcome with respect to early morbidity and mortality rates, as well as vascular reconstruction patency. PATIENTS AND METHODS: 13 patients (14 vascular resections) required a concomitant resection of a major vascular structure and vascular reconstruction in an attempt to achieve complete tumor resection. There were 6 males and 7 females; ages ranged from 32 to 79 years (mean age 51 years). Superior mesenteric vein and portal vein was resected in 9 cases: portal vein (7), portal vein and left portal vein (1) and superior mesenteric vein and right hepatic artery (1). The primary disease was: pancreas cancer (3), solid tumor pancreatic head (1), gallbladder cancer (2), cholangiocarcinoma (2) and recurrent liver metastasis from colon cancer (1). Multivisceral resection was performed: Pancreatoduodenectomy (4), pancreatoduodenectomy + central hepatectomy (2), right hepatectomy extended to segment IV + extrahepatic biliary duct resection (1), liver segmentectomy (S IV) + partial gastroduodenectomy + extrahepatic and intrahepatic biliary duct resection (1) and extrahepatic biliary duct resection (1). Hepatic artery was resected in 4 cases: main (1) and right hepatic artery (3). The surgical technique was: pancreatoduodenectomy (3) and left hepatectomy + biliary duct confluence (1). RESULTS: The morbidity and mortality related to vascular reconstruction was 14% (2/14) and 7% (1/13), respectively. The early and late patency vascular reconstruction was 100%. The 1-year survival was 100%, 66% and 33% for patients operated by liver metastasis, gallbladder cancer and cholangiocarcinoma, respectively. CONCLUSION: Our initial experience suggest that vascular resections in advanced HPB tumors can be performed in selected cases safely with acceptable morbidity and mortality. Multivisceral resection associated with vascular resection can offer a good palliation for patients with advanced tumors.

29 PREDICTIVE VALUE OF PREOPERATIVE HEPATOBILIARY SCINTIGRAPHY ON MORBIDITY AND MORTALITY AFTER PARTIAL LIVER RESECTION

Dinant S[1], Verwer BJ[1], Bennink RJ[2], Gouma DJ[3], van Vliet AK[1], van Gulik TM[1], (1) Surgical Laboratory; (2) Nuclear Medicine; (3) Surgery, Academic Medical Center, Amsterdam, The Netherlands

INTRODUCTION AND AIM: Postoperative liver failure, caused by impaired remnant liver function, is still the most important determinant of morbidity and mortality after partial liver resection. Future remnant liver (FRL) function can be calculated with hepatobiliary scintigraphy (HBS). The aim of this study was to compare the predictive value of FRL uptake function using HBS with volume assessment of the FRL. PATIENTS AND METHODS: 55 consecutive patients scheduled to undergo partial liver resection, of which 20 (40%) had underlying parenchymal disease, were included. FRL uptake function (%/min/L) was calculated with HBS using Tc-Mebrofenin. FRL volume (% of total liver volume) was calculated by subtracting resected liver volume from total liver volume. Outcome parameters were morbidity, liver failure and mortality. RESULTS: Morbidity and mortality were 71% and 13%, respectively. Liver failure occurred in 7 patients (13%) of which 5 patients died during hospital stay (9%). Receiver operating characteristic curves showed that FRL uptake function was accurate in predicting increased risk of liver failure and mortality (area under the curve (AUC) 89.0% and 86.8%, respectively). FRL volume was accurate only in predicting increased risk of total morbidity (AUC 78.0%). Calculated cut-off values were 69% for total morbidity (sensitivity 81%, specificity 76%), 2.9%/min/L for liver failure (sensitivity 86%, specificity 90%) and 2.8%/min/L for mortality (sensitivity 80%, specificity 90%) caused by liver failure. CONCLUSION: FRL uptake function is more valuable than FRL volume for identifying patients with increased risk of liver failure or mortality after partial liver resection.

30 SURGICAL TREATMENT OF LIVER HYDATID CYSTS

Ezer A[1], Haberal MA[2], Nursal T[1], Moray G[1], Yýldýrým S[1], Karakayali F[1], Noyan T[1], Haberal M[2], (1) General Surgery; (2) General Surgery Division of Transplantation, Baskent University Faculty of Medicine, Ankara, Turkey

INTRODUCTION AND AIM: Although percutaneous treatment is advocated as a first line therapy in selected cases, surgery still remains as a main treatment option for advanced stages of liver hydatid cysts (LHC). PATIENTS AND METHODS: In this study we present our treatment strategies in LHC. A total of 44 patients were operated for LHC between December 1998 and October 2004 in our center. For preoperative staging and in order to determine the extent of the disease, we evaluated our patients with ultrasonography

and computed tomography. All patients were treated with albendazol (10 mg/kg/day) for 15 days preoperatively. RESULTS: 24 (53%) of these patients were female and 20 were male. The median age was 52.5 years (range 19–81). The majority of the patients ($n=27$) had one cyst and the remaining 17 patients had multiple cysts. Only 3 patients (7%) had stage I disease. Total pericystectomy was performed in 3 patients (7%). Partial cystectomy and its modifications were performed for the remaining 41 (93%) patients. In 4 patients (9.1%) daughter cysts were found in the biliary system, and abscesses were present in 3 patients (7%). Biliary ducts were draining into the cyst cavity in 13 patients (30%). Nine patients (20.5%) had postoperative complications. Bile drainage through the postoperative drain was the most frequent complication ($n=5$). Three patients had wound infections ($n=3$). Also deep venous thrombosis, hypernatremia, and diaphragmatic injury was observed in one patient each. Follow-up was complete for 33 patients (75%). The mean postoperative follow-up was 11.9 ± 10.8 months. There were 4 recurrences during this time period. CONCLUSION: Surgical treatment technique of LHC cannot be standardized and surgical technique should be tailored according to extent of the cyst and adjunct complications due to the hydatid disease. The main aim should be to provide complete drainage and obliteration of the cavity. Bile leak and biliary obstruction may complicate the postoperative course if bile leak to the peritoneal cavity and obstruction in the biliary system were missed.

31 *DECREASING MORTALITY AND MORBIDITY AFTER LIVER RESECTIONS DESPITE MORE EXTENDED RESECTIONS*

Adam U, Makowiec F, Fischer E, Hopt U, University of Freiburg, Department of Surgery, Freiburg, Germany

INTRODUCTION AND AIM: Regarding operative technique and perioperative morbidity liver resections are among the most challenging operations and are also discussed to be performed in 'high-volume centers'. We analyzed the perioperative outcome of 231 liver resections performed from 1998 to 2004. PATIENTS AND METHODS: From 1998 until 3/2004, 231 major liver resections (one fourth extended hemihepatectomies) were perfomed, most of them for colorectal cancer metastases followed by hepatocellular carcinoma. The perioperative course was compared between period P1 (8/2001) and period P2 (from 9/2001). RESULTS: The median number of resections increased from 24 (P1) to 53 (P2). The proportion of extended hemihepatectomies in P2 was significantly higher compared to P1. The complication rate decreased from 58% to 45%. This effect was even stronger in colorectal cancer metastases. Mortality decreased from 10% (P1) to 3% (P2; $p<0.05$). Since September 2001 none of 90 patients died perioperatively after resection of colorectal cancer metastases. Both the median number of blood transfusions (3 units in P1 vs 0 units in P2; $p<0.05$) and the median postoperative length of stay (15 days in P1 vs 13 days in P2; $p<0.05$) decreased significantly during the study period. CONCLUSION: Increasing center experience may contribute to a reduction of morbidity and mortality after major liver resections despite more extended resections. Especially in patients with metastasis of colorectal cancer (and otherwise healthy liver tissue) a perioperative mortality near zero seems to be possible.

32 *SELECTIVE CONTROL OF GLISSONIAN PEDICLE IN RIGHT HEPATIC SEGMENTECTOMIES*

Grondona JP[2], Bracco R[1], (1) HPB Unit, Clinica Pueyrredon de Mar del Plata, Buenos Aires, Argentina; (2) Centro Medico Martin y Omar de San Isidro, HPB Unit, Martinez, Argentina

INTRODUCTION AND AIM: The intrahepatic approach and the individualization of Glissonian pedicles, mainly in the right hemiliver, facilitate the selective ischemia of the Couinaud segments. In countries where it is done, this technique is still limited principally due to the difficulty of outlining the segmentary anatomy of the liver in surgery. The aim of this paper is to describe the benefits of the intrahepatic approach technique of Glissonian pedicles. PATIENTS AND METHODS: Of 79 resections in the right hemiliver performed between 1998 and 2004, a selective control of Glissonian pedicles was carried out in 16 of them (20.2%) Segments V, VI, VII and VIII were resected individually or in pairs. The right branch of the portal vein and its paramedian and lateral divisions were isolated with the subsequent selective ischemia of the respective segments. RESULTS: The ischemia delimitation obtained was ostensible and then completed with continuous cautery outline. A subhepatic biliary collection was drained percutaneously, and neither hepatic insufficiency nor postoperative mortality were observed. CONCLUSION: With this procedure there is certainty that the parenchymal area to be resected corresponds to the Couinaud segment previously selected. The results obtained induce us to continue with the use of this technique, as by adjusting the hepatic resection to the number and size of the lesions, unnecessary ischemia of the remaining parenchyma will be avoided.

33 *ISOLATED CAUDATE LOBE RESECTION FOR METASTATIC COLORECTAL CANCER AND INTRAHEPATIC DUCT STONES—CASE REPORT*

Won YS, Park IY, Cho HM, Chin HM, Kim JG, Park WB, Chun CS, Surgery, Catholic University of Korea, Suwon, South Korea

INTRODUCTION AND AIM: Liver metastases complicate 20–30% of cases of colorectal cancer. Among these, metastases to the caudate lobe are very rare. Resection of the caudate lobe is considered extremely difficult and highly dangerous, but early diagnosis and surgical treatment of hepatic caudate lobe metastases originating from colorectal carcinoma may could further improve the survival. Also, intrahepatic duct stones cause serious problems, such as obstructive jaundice, cholanigitis, liver abscesses, etc. Hepatic resection is the treatment of choice for intrahepatic duct stones. With improving techniques in hepatobiliary surgery and aggressive surgical treatment, the outcome of intrahepatic duct stones has improved. PATIENTS AND METHODS: We have recently experienced a case of hepatic caudate lobe metastasis from rectal cancer, she underwent an isolated resection of the caudate lobe. Also, a case of intrahepatic duct stones in the caudate lobe; the patient underwent an isolated resection of caudate lobe and T-tube choledocholithotomy. RESULTS: A 44-year-old female underwent an isolated resection of the caudate lobe, the primary site was rectal cancer (T2N0M0) laparoscopic low anterior resection (6 months earlier), hepatic metastasis: caudate lobe, size 4.0×3.2 cm, preoperative labarotory findings: Hb 12.3 g/dL, WBC 4800×109/L, platelets $190\,000 \times 109$/L, AST 40 U/L, ALT 54 U/L, amylase 99 U/dL, albumin 4.2 g/dL, bilirubin (T) 0.7 mg/dL, PT 11.5 sec (123%), CEA 38.4 ng/ml, ICG R15 7.1%, intraoperative USG: no other metastatic lesion. Approach to the caudate lobe: left side approach, Pringle's maneuver (-), estimated blood loss: about 500 ml, postoperative course: uneventful. A 51-year-old female underwent an isolated resection of the caudate lobe and T-tube choledocholithotomy due to intrahepatic duct stones with cholangitis in the caudate lobe. Preoperative labarotory findings: Hb 12.7 g/dL, WBC 7580×109/L, platelets $114\,000 \times 109$/L, AST 109 U/L, ALT 58 U/L, amylase 62 U/dL, albumin 3.5 g/dL, bilirubin (T) 1.5 mg/dL, PT 10.9 sec (151%). Approach to the caudate lobe: left side approach, Pringle's maneuver (−), estimated blood loss: about 500 ml, postoperative course: uneventful. CONCLUSION: The left side approach is a useful approach for isolated caudate lobe resection. Major anatomic resections are not always necessary for tumors of the caudate lobe and for intrahepatic duct stones of caudate lobe. Careful technique and detailed anatomic knowledge of the caudate lobe are essential for feasible and safe use of this procedure.

34 *PREOPERATIVE HAEMOGLOBIN RATE: AN UNDERESTIMATED FACTOR FOR BLOOD TRANSFUSION IN LIVER SURGERY*

Stenard E[2], Mercks P[1], Dondero F[2], Sauvanet A[2], Farges O[2], Sommacale D[2], Dokmak S[2], Belghiti J[2], (1) Anesthesiology; (2) Hepato-biliary Surgery, Beaujon Hospital, Clichy, France

INTRODUCTION AND AIM: Because transfusion is related to morbidity of patients undergoing liver surgery, we retrospectively analyzed parameters linked to requirement for blood transfusion during the perioperative period in a homogeneous group of major liver resections (right hepatectomy) in a short period. PATIENTS AND METHODS: From 1998 to 2003, 272 patients of mean age $54 +/- 14$ years underwent a right hepatectomy, for malignant ($n=209$) and benign tumours ($n=63$). Pre- and per-operative data from the medical files, focusing on blood transfusion, were analyzed. All significant parameters in univariate analysis ($p<0.05$) were included in a multivariate logistic regression. RESULTS: The global

transfusion rate was 36% ($n=98$) with a median blood unit use of 3 U (2–4). In univariate analysis, the following parameters were significant: diabetes, weight of the specimen (mean: 1020 g +/− 457), duration of surgery (mean: 346 min +/− 101), preoperative prothrombin time and haemoglobinaemia. Preoperative haemoglobinaemia and duration of surgery were independently associated with blood transfusion. From these results we elaborated a model giving a continuous evaluation of peri-operative transfusion requirement linked to preoperative haemoglobinaemia rate (from 8 to 16 g/dL): thus a preoperative haemoglobinaemia value of 8, 10, 12, 14 and 16 g/dL resulted in blood transfusion risk of 75, 60, 45, 30 and 17%, respectively. CONCLUSION: During a major liver resection, there is a close relationship between preoperative haemoglobinaemia and blood transfusion. Therefore, before performing a major hepatectomy, surgeons have to focus on an optimization of preoperative haemoglobinaemia in order to decrease the rate of transfusion.

35 *HEPATIC RESECTIONS USING A WATER-COOLED, HIGH-DENSITY, MONOPOLAR DEVICE: A NEW TECHNOLOGY FOR SAFER SURGERY*

Di Carlo I, Toro A, Sofia M, Guastella T, Department of Surgical Sciences, Organ Transplantation, and Advanced Technologies, University of Catania, Catania, Italy

INTRODUCTION AND AIM: Several techniques and devices have recently been developed in an effort to allow safer liver resections and avoid intraoperative blood loss. The aim of this study was to analyze our initial experience with hepatic resections using two new water-cooled, high-density, monopolar devices—the Tissuelink Monopolar Floating Ball and Dissecting Sealer (Tissuelink Medical, Inc., Dover, NH)—in order to avoid bleeding during hepatic surgery. PATIENTS AND METHODS: We analyzed patients who underwent hepatic surgery between January 2003 and June 2004. Sex, age, type of disease, and type of surgical procedure, in association with the duration of the surgical procedure, blood loss, use of vascular clamping of the liver, length of hospital stay, morbidity, and mortality were analyzed. RESULTS: Ten minor liver resections, two major liver resections, and two total cystopericystectomy were performed with the use of these new devices. Average blood loss was 150 ml (range 50–300). No vascular clamping was used with the exception of one patient. No deaths were recorded. Morbidity included ascites in one case and pleural effusion in another. CONCLUSION: In conclusion, these new devices permitted excellent coagulation of the cut liver surface, thus avoiding bleeding and vascular clamping. As a result, postoperative morbidity and mortality were low.

36 *COMPARISON OF TWO NEW TECHNIQUES FOR LIVER TRANSECTION DURING HEPATECTOMY. RADIOFREQUENCY ENERGY VS LIGASURE SEALING SYSTEM: AN ANIMAL STUDY*

Tepetes K, Spyridakis M, Theodoropoulos T, Zacharoulis D, Tzovaras G, Hatzitheofilou C, Surgery, University Hospital of Larissa, Greece

INTRODUCTION AND AIM: The aim of the reported study was to compare two new vessel sealing devices currently used in liver resections. PATIENTS AND METHODS: Ten pigs weighing 20–25 kg were used. Overall, 20 hepatic lobectomies were carried out (2 per animal). Six pigs (Group A) underwent liver resections with the transection plane coagulated prior to the division with a modification of the cluster cool-tip Radionics radiofrequency electrode. In the remaining 4 pigs (Group B) the liver resections were performed using the Atlas LigaSure clamp. RESULTS: The blood loss per lobectomy in Group A varied from 5 to 15 ml (mean 8), whereas in Group B the blood loss was 30–55 ml (mean 45). Regarding the histological alterations, the hepatocyte and connective tissue necrosis was more severe in Group B than in Group A. However, the depth of the coagulative necrosis zone was the same in these two groups (approx. 1 cm). CONCLUSION: Although the study is not completed yet in order to draw statistically significant conclusions, it seems that the application of the radiofrequency energy in liver resections is associated with less blood loss and less severe collateral thermal damage than the use of the LigaSure vessel sealing system.

37 *GIANT HEPATIC HYDATID CYST: CASE REPORT*

Ezer A, Haberal MA, Emiroðlu R, Yagmurdur MC, Çolakoðlu T, Noyan T, General Surgery, Baskent University Faculty of Medicine, Ankara, Turkey

INTRODUCTION AND AIM: Although percutaneous drainage is the preferred way to treat stage I and II liver hydatid disease, surgery can be a feasible choice for some cases. Large type 1 cysts are prone to perforation and insufficient drainage may cause subsequent abscess formation in the cyst cavity. PATIENTS AND METHODS: The first case was a 19-year-old man who was admitted to the hospital with pain in the right upper quadrant and epigastric region. An asymmetrical right upper quadrant enlargement was detected on physical examination. Ultrasonography and computerized tomography revealed a type 1 giant hydatid cyst in the right hepatic lobe which was 16 cm at its largest diameter. Partial cystectomy was performed and the large cyst cavity was obliterated by the 'sandwich' method. The residual cavity was minimized by manual approximation of the surrounding liver parenchyma from both sides. Omentum and gelatine sponges were used to fill the cavity. The fibrous capsule that is deliberately left around the liver rim was then closed with mattress sutures. Two drains were placed, one in the cavity and one in the subhepatic space. RESULTS: The postoperative course was uneventful and the patient was discharged on the 5th postoperative day. Follow-up was 2 months and there were no additional complications. The second case was a 22-year-old woman who was admitted to our hospital with abdominal pain, hyper biluribinemia and lassitude. This patient had an exploratory laparotomy and was referred to our hospital for liver transplantation. Her radiological examination determined that the right hepatic artery, right portal vein and right hepatic vein were occluded. The right and the left hepatic ducts were opening into the cyst cavity. The hydatid cyst volume was 14×14 cm and it was constricting the left hepatic artery. A stent was placed to the hepatic artery by percutaneous intervention. After that right hepatectomy and hepatico-jejenostomy over an internal/external stent was performed. Leakage from the hepatico-jejenostomy occurred and the stent was left open for external drainage and after 3 months the leak ceased. CONCLUSION: Hydatid disease is still a community problem in some countries. Complicated and demanding surgical manipulations may be needed to treat the disease and its complications.

38 *MAJOR LIVER RUPTURE IN COMBINATION WITH MASSIVE BLOOD TRANSFUSION: REPORT OF 2 CASES*

Lapidakis G[1], Lapidakis E[1], Papoutsis G[1], Grouzi E[2], Spiliotopoulou I[2], Manteli-Lapidaki C[3], (1) Second Department of General Surgery; (2) Transfusion Service; (3) Anaesthesiology, "KAT" Hospital, Athens, Greece, Kifisia, Attiki, Greece

INTRODUCTION AND AIM: Traumatic ruptures of the liver constitute a major problem for the general surgeon as immediate clinical assessment and management is required, since massive blood loss could lead to hematogenic shock. Generally support with blood transfusion is needed and often a massive blood transfusion (transfusion of >10 units of condensed red blood cells (RBCs) in 24 h) is required. This fact constitutes an added burden for the patient's condition, because of the considerable complications and the administration problems of the blood bank departments, and possibly deteriorating patient's prognosis. PATIENTS AND METHODS: Two cases are presented (patients A and B) with major liver rupture, who underwent multiple operations during their hospitalisation and massive blood transfusion was required. Patient A: massive transfusion of 43 units of condensed RBCs out of a total of 69. Patient B: massive transfusion of 18 units of condensed RBCs out of a total of 34. Both patients were treated as intensive care unit patients. Several complications were treated with surgical or conventional methods. RESULTS: In spite of the gravity of their traumas and the massive blood transfusions, both patients were released from the hospital after long hospitalisation in good condition. Both are still in good condition 15 months (patient A) and 3 months (patient B) after their release from the hospital. CONCLUSION: The patients' condition demonstrates that excessive blood transfusion does not constitute a negative factor for aggressive treatment of a traumatic patient or a patient whose life is directly in danger.

39 INDICATIONS AND TREATMENT OF HEPATOLITHIASIS IN A WESTERN COUNTRY

Ramia JM[1], Muffak K[1], Palomeque A[1], Villar J[2], Garrote D[1], Ferrón JA[1], (1) General Surgery; (2) Surgery, UH Virgen de las Nieves, Granada, Spain

INTRODUCTION AND AIM: The main objective is to present our experience in the treatment of hepatolithiasis. PATIENTS AND METHODS: This was a retrospective study. We included every patient operated on in the period 2002–2004. RESULTS: Mean age was 68.2 years. All patients were male. Two patients had been operated on before. The other three suffered: monolobar Caroli disease (1), cholangiocarcinoma (1) and hepatolithiasis without clear etiological factors (1). All of them had intrahepatic and extrahepatic litihiasis. Clinical signs were: pain in right upper quadrant, fever and jaundice. Bilirubin was 3.5 mg/dl (min: 1.7, max: 5.9), GGT: 676.2 UI/l (min: 29, max: 2039), and phosphatase alkaline: 400 UI/l (min: 100, max.1136). Abdominal ultrasound always diagnosed hepatolithiasis correctly. CT was performed in 3 patients, and only diagnosed one case adequately. ERCP (3 patients) and CholangioRMN (2 patients) always diagnosed hepatolithiasis correctly. Surgical procedures were: hepaticojejunostomy with lavage of the bile duct (2 cases) and hemihepatectomy (3 cases): right (1) and left (2). We always performed intraoperative ultrasound and choledoscopy. Morbidity was: biliary fístula (1 case) treated by percutaneous drainage. No mortality occurred. Median stay was 8.8 days. Mean follow-up is 12 months (min: 11, max: 20). No relapse has been observed. CONCLUSION: Hepatolithiasis is uncommon in Spain. In westen countries there are several causes of hepatolithiasis (e.g. Caroli disease, previous surgery). Surgical treatment, usually liver resection, obtains good results with low morbidity and mortality.

40 HEPATIC RESECTION USING RADIOFREQUENCY ENERGY

Park IY[2], Lee K[1], Yoo Y[1], Won Y[1], Lee S[1], (1) Surgery, Catholic University of Korea; (2) Holy Family Hospital, Catholic University of Korea, Surgery, Bucheon, Korea

INTRODUCTION AND AIM: Radiofrequency (RF) ablation has been widely accepted as an effective modality for the treatment of liver tumors. It can be delivered either percutaneously or at open operation; however, it is only one of the palliative modalities. Recently, the role of radiofrequency energy in liver surgery was expended in some reports. PATIENTS AND METHODS: We made a plane of coagulation necrosis for the parenchymal transection by using the RF energy in 6 patients. There were 4 men and 2 women of median age 59.5 years (range 48–66). There were 5 hepatocellular carcinomas and 1 hemangioma. RESULTS: In all patients, hepatic resection was performed successfully using RF energy; partial resection in 5 cases, left lateral sectionectomy with subsegmentectomy in 1 case. Pringle's maneuver was not applied in any case. Median blood loss was 450 ml. One patient received blood transfusion. Median hospital stay was 13 days. Major morbidities were ascites (2 cases). One patient died after 2 months due to esophageal varix bleeding. CONCLUSION: Liver resection using RF energy is an effective method to avoid intraoperative hemorrhage during parenchymal resection of the liver. However, the number of cases in our study was small and further evaluation is need.

41 SURGICAL TREATMENT OF POLYCYSTIC LIVER DISEASE

Pekolj J, Quiñonez E, Palavecino M, Bertona C, de Santibañes E, Hepato-Pancreato-Biliary Surgery and Liver Transplantation, Hospital Italiano, Buenos Aires, Argentina

INTRODUCTION AND AIM: Polycystic liver disease (PLD) is an autosomal dominant syndrome. It is generally asymptomatic and it is frequently associated with polycystic kidney disease. The aim of this study is to show a surgical treatment of polycystic liver disease (Moroni classification type II). PATIENTS AND METHODS: A 57-year-old female patient with PLD was on the waiting list for a kidney transplantation. She presented multiple hepatic cystic images in an MRI and in US. Her chief complaint was an epigastric pain with dyspepsia and a weight loss of 5 kg in the last 30 days. We decided to perform a hepatic resection (left hepatectomy) without Pringle maneuver and to unroof two big cysts in the right liver. RESULTS: She was discharged on the 7th day without complications. Two months after, she underwent a kidney transplantation with a living-related donor. There has been 1-year follow-up without incidents. CONCLUSION: Hepatic resections can be safely performed in patients with this pathology. There is no consensus as to which is the best procedure for these patients.

42 TACHOSIL AS HAEMOSTATIC TREATMENT IN HEPATIC SURGERY

Broelsch C[1], Frühaus NR[1], de Hemptinne B[2], Klempnauer J[3], Mischinger HJ[4], Büchler M[5], Gassel J[6], Rokkjaer M[7], Kupcsulik P[8], Schauer R[9], Noergaard Larsen P[10], (1) Department of General and Transplantation Surgery, University Hospital of Essen; Germany; (2) University Hospital of Gent, Belgium; (3) Medical University of Hannover, Germany; (4) University Hospital of Graz, Austria; (5) University Hospital of Heidelberg, Germany; (6) University Hospital of Würzburg, Germany; (7) Aarhus University Hospital, Denmark; (8) Budapest Semmelweis University, Hungary; (9) University Hospital of Munich-Grosshadern, Germany; (10) Copenhagen University Hospital, Denmark

INTRODUCTION AND AIM: Diffuse (oozing) bleeding from the raw resection surface of the liver remains a challenge for the hepatic surgeon. The aim of the present work was to evaluate a new ready-to-use and atraumatic haemostatic, TachoSil, as adjunct treatment of diffuse haemorrhage in liver surgery. PATIENTS AND METHODS: Between March and August 2003, 119 patients scheduled for at least segmental resection of the liver for any reason were included in a prospective, randomised, controlled trial at 10 centres. The patients were all Caucasian with a mean age of 59.5 years, 41% were females and 59% males. Liver resection was followed by primary haemostatic treatment with sutures, ligations and clips to obtain oozing or moderate bleeding. The patients were then randomised to either TachoSil or argon beamer as secondary haemostatic. Primary endpoint, time to haemostasis, was analysed by a log-rank test. Drainage variables were analysed by ANOVA. RESULTS: TachoSil was significantly superior to argon beam coagulation with a mean time to haemostasis of 3.6 and 5.0 min, respectively ($p=0.0018$). The estimated ratio TachoSil/argon beamer of mean time to haemostasis was 0.61 (95% CI: 0.47–0.80; $p=0.0003$). Postoperative drainage variables showed less drainage fluid and shorter drainage duration with TachoSil, although the difference did not reach statistical significance. Adverse events were equally distributed between the treatments. CONCLUSION: The fixed combination fibrin sealant TachoSil proved efficacious and safe for control of diffuse and moderate haemorrhage in liver surgery. TachoSil may thus be regarded a new treatment option to achieve reliable haemostasis in parenchymatous organ surgery.

43 EXTENDED LEFT HEPATECTOMY—A PERIOPERATIVE RISK ANALYSIS

Lang H, Brokalaki E, Frühauf NR, Molmenti E, Paul A, Malagó M, Broelsch CE, Sotiropoulos G, Klinik für Allgemein- und Transplantationschirurgie, Universitätsklinikum Essen, Essen, Germany

INTRODUCTION AND AIM: Although the surgical technique of extended left hepatectomy (resection of liver segments II, III, IV, V, VIII $\pm$ I) was described more than 20 years ago in 1982 by Starzl there are still few data about this operation. Extended left hepatectomy—a perioperative risk analysis. PATIENTS AND METHODS: Preoperative findings (pre-treatment, concomitant diseases, laboratory data) as well as intra- and postoperative data including pathology of 59 adult patients were evaluated with regard to perioperative complications using multivariate analysis. RESULTS: In addition to extended left hepatectomy the following procedures were performed: resection of hilar bifurcation ($n=16$), wedge excision of segments VI/VIII ($n=11$), vascular resection/reconstruction ($n=11$) gastrectomy ($n=1$). Most frequent concomitant diseases were hypertension ($n=12$), diabetes mellitus ($n=6$), severe coronary heart or obstructive lung disease ($n=5$, each). Systemic or local pretreatment had been performed in 20 patients. Duration of operation was 320 min (192–690 min), requirement for packed red blood cells was 3 units (0–20 units). 20 and 10 resections were performed under hilar (22 min; 4–48 min) or total vascular occlusion (15 min, 4–25 min) (data as median and range). Perioperative morbidity and mortality was 56% and 11.9%, respectively. 20 patients underwent reoperation and/or percutaneous/endoluminal placement of drainages. None of the investigated parameters correlated significantly with hospital mortality. CONCLUSION: Despite major progress in

surgical techniques and perioperative management, extended left hepatectomy is still associated with a high morbidity and mortality. Suitable variables for proper patients' selection are still missing. Therefore, when considering this operation particular attention has to be paid to oncologic aspects because of the mostly advanced tumors.

44 *PRECOAGULATION MINIMIZES BLOOD LOSS DURING STANDARDIZED HEPATIC RESECTION IN A PORCINE MODEL*

Fioole B[1], van der Bilt JDW[1], Elias SG[2], de Hoog J[1], Borel Rinkes IHM[1], (1) Surgery, University Medical Centre Utrecht; (2) Julius Center for Health Sciences and Primary Care, Utrecht, The Netherlands

INTRODUCTION AND AIM: Precoagulation of liver tissue prior to transection is a novel concept in hepatic surgery. Comparative data with conventional techniques are lacking. Here, the hypothesis that precoagulation results in a decrease of blood loss during hepatic transection was tested. PATIENTS AND METHODS: Precoagulation was tested using two different devices, TissueLink floating ball (group A) and dissecting sealer (group B), and compared with ultrasonic dissection (group C). With each technique 12 partial liver resections were performed in 6 pigs. The left and right medial lobes were resected in each animal. Blood loss and dissecting time were the main outcome parameters. The animals were terminated on the fifth postoperative day and the abdomen was inspected for complications. RESULTS: Transected surface area was similar in all groups. Animals in groups A and B experienced significantly less blood loss when compared with those in group C (3.57, and 1.30 vs 11.9 ml/cm^2, respectively, $p=0.009$ and 0.002). Duration of transection in group A was longer than in group C (2.42 vs 1.76 min/cm^2; $p=0.004$), while the duration of transection in group B was similar to that in group C (1.85 vs 1.76 min/cm^2; $p=0.713$). One pig operated on in group A died as a result of wound dehiscence. In group B a gastric perforation was observed after termination. In group C bile leakage was observed in 2 animals and a large hematoma on the transection surface was observed in 1 animal after termination. CONCLUSION: Precoagulating liver tissue prior to transection is associated with less blood loss than ultrasonic dissection.

45 *THE EFFECT OF DEGREE OF STEATOSIS ON LIVER REGENERATION IN A RAT MODEL*

Veteläinen R, van Vliet A, van Gulik T, Surgery, Surgical Laboratory, Academic Medical Center, Amsterdam, The Netherlands

INTRODUCTION AND AIM: Steatosis influences liver regeneration but the effect of the severity of steatosis and steatohepatitis on liver regeneration remains unclear. We assessed the effect of the degree of steatosis on liver regeneration after 70% hepatectomy. PATIENTS AND METHODS: Methione- and choline-deficient diet (MCDD) was used to induce steatosis and steatohepatitis. Rats were divided into three groups ($n=5$): MCDD 1 week, MCDD 5 weeks and normal diet. At 24, 48 and 72 h after 70% hepatectomy, liver regeneration (MIB-5 proliferation and mitotic indexes and regenerating liver mass) and hepatocellular injury (ALT, bilirubin, histology by H&E stain) and apoptosis were assessed. RESULTS: MCDD diet induced steatosis after 1 week ($<30\%$ hepatocytes) and steatohepatitis after 5 weeks ($>60\%$ steatosis, inflammatory activity, mild fibrosis). After 70% hepatectomy, the increase in regenerating liver mass was lowest in the steatohepatitis group $10\pm1.2\%$, $20\pm1.8\%$ and $25\pm2.9\%$ at 24 h, 48 h and 72 h, respectively (in the steatosis group: $20\pm0.9\%$, $29\pm2.2\%$, $32\pm1.8\%$ and in the control group: $21\pm1.0\%$, $29\pm0.3\%$, $35\pm2.1\%$, $p<0.05$). Also in the steatohepatitis group MIB-5 ($24\pm6.5\%$) and mitotic indexes ($1.3\pm0.1\%$) were lowest at 48 h compared to the steatotic and control groups (MIB-5: $50\pm3.7\%$ and $41\pm2.2\%$ and mitotic index: $2.0\pm0.5\%$ and $1.9\pm0.1\%$ in steatosis and control groups, respectively, $p<0.05$. ALT and bilirubin were significantly higher in the steatohepatitis group at all time points ($p<0.05$). Also the percentage of apoptotic hepatocytes stayed increased and histology showed more damage ($p<0.05$). CONCLUSION: The presence of inflammation together with steatosis impaired liver regeneration and increased liver injury after hepatectomy, suggesting increased risk when performing extensive resection in the presence of steatohepatitis.

46 *COMPARISON OF PORTAL VEIN EMBOLIZATION VERSUS PORTAL VEIN LIGATION FOR INDUCTION OF HYPERPLASIA OF THE FUTURE REMNANT LIVER VOLUME USING A MINI-PIG MODEL*

Wilms C[1], Mueller L[1], Lenk C[1], Hillert C[1], Krupski G[2], Helmke K[3], Rogiers X[1], Broering DC[1], (1) Department of Hepatobiliary Surgery and Viceral Transplantation;(2) Department of Radiology;(3) Department of Pediatric Radiology, University Hospital Hamburg-Eppendorf, Hamburg, Germany

INTRODUCTION AND AIM: The extent of hepatectomies is limited by the functional reserve of the remnant liver. The introduction of preoperative portal vein occlusion techniques to induce a preoperative hyperplasia of the future liver remnant reduced the risk of postoperative liver failure. However, it has remained a matter of debate whether partial portal vein embolization or ligation of the portal branches is the preferable technique. We compared both techniques under standardised conditions in a large animal model. PATIENTS AND METHODS: Mini-pigs weighing 23–55 kg were used. 13 animals underwent portal vein ligation (PL), 11 animals underwent portal vein embolization (PE) of 75% of the liver volume. Six mini-pigs underwent a sham operation (S). The growth responses of the non-occluded liver lobe and the occluded liver lobes were assessed by segmental liver weight to body weight ratio (SLBWR) 4 weeks postoperatively. Hepatocellular damage and liver function were monitored by serum determinations. Duplex ultrasound examinations of hepatic flow parameters before and 1 h after ligation/embolization and after 4 weeks were undertaken. *Ex situ* arteriograms and portograms were used to show adaptive changes in both vascular beds. RESULTS: The SLBWR of the non-occluded lobe was highest after PE (0.85; $p<0.05$) versus 0.6 ($p<0.05$) after PL. In the S-group it was 0.4. In contrast, the weight indices of the occluded lobes were significantly reduced. Transaminases were not significantly elevated after both occlusion techniques. Global serum parameters reflected normal liver function. After PL, there was a temporary reversal portal flow 1 h after occlusion. After four weeks, the PL group consistently exhibited hepatopetal portal flow in the ligated lobes, which was present, but significantly decreased after PE. The *ex situ* angiography after PE and PL revealed the development of portal neo-collaterals in the portal-occluded liver parts. CONCLUSION: PE is the more effective technique to increase the future liver remnant. This is due to a more effective, durable occlusion of the portal branches. Formation of collaterals between occluded and non-occluded liver parts seems to be the cause of inferior regeneration in the ligation group. The level of growth in the non-occluded lobes is balanced by atrophy in the occluded lobes.

47 *PROTECTIVE EFFECT OF ISCHEMIC PRECONDITIONING AGAINST ISCHEMIA REPERFUSION INJURY AFTER MAJOR HEPATECTOMY USING INTERMITTENT PRINGLE'S MANEUVER IN SWINE*

Shimoda M, Iwasaki Y, Sawada T, Kubota K, Second Department of Surgery, Dokkyo University School of Medicine, Mibu, Tochigi, Japan

INTRODUCTION AND AIM: Although ischemic preconditioning (IPC) has been reported to protect liver injury after hepatectomy using continuous Pringle's maneuver, it has not been clarified whether IPC protects liver against injury after hepatectomy using intermittent Pringle's maneuver. PATIENTS AND METHODS: Male white swine (BW: $20\sim28$ kg; $n=10$) were used. Laparotomy using chevron incision was performed under general anesthesia. To prevent intestinal congestion during prolonged occlusion of the portal vein and hepatic artery, veno-venous bypass was created between the right internal jugular vein and the main splenic vein. Left hemihepatectomy (approximately 40%) was performed under Pringle's maneuver (15 min clamp and 5 min release) during hepatic resection. IPC group ($n=5$): livers were subjected to IPC (hepatic ischemia for 10 min followed by reperfusion for 10 min) before intermittent Pringle's maneuver. None IPC group ($n=5$): livers were subjected to only intermittent Pringle's maneuver during hepatectomy. Liver damage after hepatectomy was evaluated between the two groups by monitoring hemodynamics and biochemical examination. Serum GOT, GPT, LDH, hyaluronic acid, lactic acid, NOx, TNF-alpha were measured after reperfusion. Histological and apoptotic findings were also evaluated after reperfusion for 180 min. Statistical analysis was performed using ANOVA. All values are expressed as means SD. RESULTS: There were no significant

differences in body weight, blood loss, hemodynamics, Pringle's maneuver time and resected liver weight between the two groups. IPC significantly reduced serum transaminase level (GOT: IPC: 135.8+/−13.5 vs non-IPC: 199+/−16.8, $p=0.018$) and plasma TNF-alpha level (IPC: 225.3+/−60.1 vs non-IPC: 760.4+/−437.7, $p=0.042$). Although serum levels of LDH, lactic acid, hyaluronic acid and NOx in the IPC group were elevated less than those in the non-IPC group, there were no statically significant differences between the two groups. In hepatic tissue, TUNEL-positive cells were significantly reduced in the IPC group. CONCLUSION: IPC exerts an effect against reperfusion injury hepatectomy with intermittent Pringle's maneuver.

48 *EFFECT OF PORTO-SYSTEMIC SHUNT ON LIVER REGENERATION: EXPERIMENTAL STUDY IN PIGS*

Ladurner R[6], Hochleitner B[1], Bodner G[2], Offner F[5], Klima G[3], Krismer A[4], Margreiter R[1], Königsrainer A[6], (1) General and Transplant Surgery, University Hospital Innsbruck; (2) Radiology, University Hospital Innsbruck; (3) Institute of Histology, University Hospital Innsbruck; (4) Anaesthesiology and Critical Care, University Hospital Innsbruck, Innsbruck, Austria; (5) Pathology, General Hospital Feldkirch, Feldkirch, Austria; (6) General and Transplant Surgery, University Hospital Tübingen, Tübingen, Germany

INTRODUCTION AND AIM: Segmental liver grafts with a calculated ideal liver weight less than 30% are supposed to be associated with portal flow-related injuries. This study evaluated the effect of porto-caval shunts on liver regeneration in a resection model in pigs. PATIENTS AND METHODS: A 75% hepatectomy was performed in 16 pigs, in 8 after carrying out a side-to-side porto-caval interposition shunt. Liver function, liver biopsies and hemodynamic examinations with power Doppler ultrasound were assessed postoperatively until day 8. Animals were observed till their death or sacrifice on day 19. RESULTS: None of the pigs died from surgical complications. In the shunt group portal blood flow was significantly lower and arterial flow significantly higher than after resection alone. Regeneration rate (remnant liver volume at follow-up/remnant liver volume after surgery) was high irrespective of surgical procedure. Liver necrosis was seen in both groups, more centrolobular after extended resection alone and more lobular/periportal after resection and porto-caval shunt. Nevertheless long-term survivors in both groups showed complete normal histomorphological liver architecture at the time of sacrifice. CONCLUSION: In our study porto-systemic shunt showed no particular effect on liver regeneration after extended hepatectomy. More data, however, particularly immediately after resection, are therefore required for a more complete understanding of portal hyperperfusion in small liver remnants.

49 *90 CONSECUTIVE PORTAL VEIN EMBOLIZATIONS TO EXTEND RESECTABILITY OF LIVER AND BILE DUCT TUMORS*

Hillert C[2], Krupski G[1], Rogiers X[2], Broering D[2], Moeller L[2], Mueller L[2], Lenk C[2], (1) Radiology; (2) Hepatobiliary Surgery, University Hamburg Hospitals, Hamburg, Germany

INTRODUCTION AND AIM: Only 20% of liver and bile duct tumors are resectable at time of diagnosis; small remnant liver volume is one of the major causes. Occlusion of the right portal branch has been proved to increase left liver volume and resectability. The feasibility and results of 90 portal embolizations will be discussed. PATIENTS AND METHODS: Since 1995, 87 patients with primary ($n=40$) and secondary ($n=47$) liver and bile duct tumors received 90 right portal vein embolizations using Histoacryl and Lipiodol due to small prospective remnant liver of $<0.5\%$ of body weight to increase resectability. RESULTS: In 5.5% ($n=5$) percutaneous approach was not possible and transmesenterial puncture via mini-laparotomy was necessary. One patient died after bile leakage and consecutive peritonitis (1%). In 2 patients (2%) embolisate dislocated into left portal branch without consequences. Subcapsular hematoma was seen in 2 cases, which circumvented resection (overall morbidity 4%). Prospective remnant liver volume increased from 276 ± 78 ml to 440 ± 114 ml ($0.38\pm0.1\%$ to $0.59\pm0.17\%$ of body weight). A curative resection was achieved in 46 of 87 patients (53%). 6 patients are waiting at present, 35 (40%) patients were not resected due to extrahepatic tumor progress ($n=5$, 6%), intrahepatic progress ($n=12$, 14%), insufficient growth of left lateral segments ($n=7$, 8%), general condition ($n=2$, 2%), complications (hematoma, peritonitis, $n=2$, 2%) and fibrosis ($n=2$, 2%). CONCLUSION: Portal vein embolization is a safe and effective method to increase resectability of liver tumors. The high rate of patients not resectable after intervention underlines the need for accurate patient selection.

50 *SURGICAL STRATEGY FOR HEPATIC TUMORS WITH TUMOR THROMBUS IN THE BILE DUCT*

Kubota K, Kita J, Shimoda M, Rokkaku K, Department of Gastroenterological Surgery, Dokkyo University School of Medicine, Tochigi, Japan

INTRODUCTION AND AIM: Not only hepatocellular carcinoma (HCC) but also metastatic tumors (Meta) and cholangiocellular carcinoma (CCC) may develop tumor thrombus in the bile duct (BTT), resulting in obstructive jaundice. The aim of this study is to establish an effective surgical strategy for hepatic tumors with BTT. PATIENTS AND METHODS: From April 2000 to November 2004, 332 hepatectomies were performed at our department (HCC: 174, Meta: 68, Bile duct cancer: 30, CCC: 16, others: 44). Preoperative US and CT suggested the presence of BTT in 10 patients (median age: 66, male/female: 8/2, HCC/Meta/CCC: 4/3/3). Their median ICG15 was 13% (4–18). The clinical course and surgical strategy of the 10 patients were retrospectively discussed. RESULTS: 4 patients presented jaundice, requiring biliary drainage. 5 patients (HCC/Meta/CCC: 2/1/2) required extended right lobectomy with ($n=4$) or without ($n=1$) bile duct resection, which was preceded by portal embolization (PE). In 2 patients with HCC, PE was preceded by TAE. Central bisegmentectomy and anterior segmentectomy with bile duct resection were performed in one patient each. The remaining 3 patients underwent left lobectomy, extended left lobectomy and partial resection. Their median bleeding amount, Pringle time and operation time were 845 ml (320–2505), 53 min (28–140) and 631 min (280–812), respectively. There was no postoperative mortality. 3 patients (HCC/Meta/CCC: 1/1/1) are alive without recurrence, while 7 developed recurrence (liver/lung: 4/3). One patient with Meta underwent resection of the lung metastasis on POD 308 and is doing well without recurrence on POD 1175. 9 of the 10 patients are alive with median survival period of 251 days (8–1175). CONCLUSION: Although hepatic tumors with BTT are considered too advanced to cure with poor prognosis, aggressive surgical approach including PE is suggested to yield acceptable results without mortality.

51 *THE PROTECTIVE EFFECT OF LISINOPRIL ON REPERFUSION INJURY IN EXTENDED PARTIAL HEPATECTOMY MODEL*

Buyukgebiz O[1], Yirmibesoglu O[1], Ars D[2], Unay Ö[2], Cevik D[2], (1) Surgery, Kocaeli University; (2) Biochemistry, Marmara University, Istanbul, Turkey

INTRODUCTION AND AIM: Lisinopril, an angiotensin converting enzyme inhibitor, could be effective in hepatic ischemia-reperfusion (IR) and this was investigated in 80% partial hepatectomy (PH) achieved by portal pedicle occlusion in rats. PATIENTS AND METHODS: Four groups of male Sprague-Dawley rats were studied: group 1, sham ($n=10$); group 2 ($n=10$), PH without pedicle occlusion; group 3 ($n=10$), PH with I/R of 40 min; group 4 ($n=15$), as group 3 with lisinopril pretreatment (1 mg/kg-1iv). Superoxide radical (O2-), nitric oxide (NO), peroxynitrite (ONOO-) levels in the liver tissue and endothelin-1 (ET-1), TNF-α, and ALT levels in retrohepatic blood were analyzed. RESULTS: ALT levels in group 3 were significantly higher than group 1 ($p<0.001$), and 2 ($p<0.01$), indicating severe hepatocellular damage in the remnant liver, although histopathologic changes were unremarkable. O2-levels increased significantly in group 2 and 3 ($p<0.01$) and lisinopril caused a remarkable decrease in group 4. NO and ONOO- levels also significantly increased in group 2 ($p<0.01$ and $p<0.05$) and group 3 ($p<0.01$ for both), when compared to group 1. In group 4, the levels of two decreased significantly only when compared to group 3 ($p<0.05$). ET-1 increase in groups 2 and 3 ($p<0.05$) was not determined in the lisinopril-treated group ($p<0.05$ and $p<0.001$, respectively). TNF-α levels did not change statistically. CONCLUSION: Lisinopril decreases the O2-, NO, ONOO-, ET-1 and ALT levels and exerts a protective role in extended PH with pedicle occlusion.

52 LIVER SURGERY PLANNING AND SIMULATION IN 3-D VIRTUAL REALITY

Sojar V[3], Kreuh D, Fius T, Velkavrh U, Hribernik M[1], Glušiè M[3], Trotovšek B[3], Stanisavljeviæ D[3], (1) Institute of Anatomy, Medical Faulty Ljubljana; (2) Department of Radiology, University Medical Centre Ljubljana; (3) Department of Abdominal Surgery, University Medical Centre Ljubljana, Ljubljana, Slovenia

INTRODUCTION AND AIM: Liver surgery is still one of the most demanding fields in surgery, and planning a liver resection always presents a challenge for a surgeon. Many authors have already described 3-D reconstructions of CT scans, which enable surgery planning. But while the reconstruction can be seen, the user cannot simulate surgery. The ultimate goal of our team has been to produce 3-D reconstructions of the CT slices and thus a virtual environment that allows planning and simulation of the surgical procedure. PATIENTS AND METHODS: The program for 3-D reconstruction from conventional CT scans has been developed so that the obtained data may be used for simulated surgery in the virtual environment. The virtual liver of the real patient has the capacity to be manipulated, dissected; moreover, the intra-operative ultrasound can be performed as in the real surgery. Precise volume measurement of liver parenchyma is possible. RESULTS: From January to October 2004 reconstructions and virtual resections were done in 40 consecutive patients planned for liver resection to evaluate clinical use of the method. All the cases showed some benefits. Presentation of tumors and relation to vessels was easy for interpretation, measurements of distances and volumes in difficult cases helped to plan appropriate and exact resection; moreover the surgeon was able to virtually operate on the patient before actual surgery. CONCLUSION: Our group successfully developed and put into clinical practice the PC-based application for liver surgery planning and simulation in a virtual environment. Prospective study would further evaluate all the benefits in clinical practice.

53 LIVER HANGING MANEUVER DURING RIGHT HEPATECTOMY: WHERE ARE THE LIMITS?

Dondero F, Sommacale D, Ogata S, Balzan S, Stenard F, Sauvanet A, Belghiti J, Liver Transplantation and Hepato-Biliary Surgery, Beaujon Hospital University Paris 7, Clichy, France

INTRODUCTION AND AIM: The hanging maneuver (HM) is an innovative technique passing a tape through the retrohepatic avascular space. In right hepatectomy (RH) the liver's suspension with the tape facilitates the hemostasis of the deeper parenchymal plane during transection. The aim of this study was to evaluate the limits of HM in RH. PATIENTS AND METHODS: Since June 2000, LH was systematically considered by 3 experienced hepato-biliary surgeons in 122 consecutive cases including 14 cirrhotic patients who planned a RH. The technical feasibility was collected prospectively. RESULTS: HM was not attempted in 19 patients (16%) because of vena caval involvement by a voluminous tumor ($n=3$), adhesion due to previous surgery with mobilization of right liver ($n=11$) and anatomical distortion observed in atrophic liver parenchyma ($n=3$). Among the 103 patients where HM was attempted, it was interrupted in 8 patients (8%) because of voluminous tumors ($n=2$), presence of a dysmorphic cirrhotic/atrophic liver after portal vein embolization ($n=3$) and transient hemorrhage during blind dissection in retrohepatic area ($n=3$). The bleeding was estimated 100–120 ml and stopped spontaneously, getting the liver in anatomical position. In the remaining 95 (92%) patients, HM was feasible (including 12 cirrhotic patients). CONCLUSION: In patients without tumours involving the vena cava and the confluence of right and middle hepatic veins our results show that passing a tape in the retrohepatic avascular space is not recommended if inflammatory or fibrotic adhesions are present between the vena cava and the liver due to previous surgery or vascular embolization. Otherwise LH during RH is a safe technique and its feasibility is higher: bleeding always stops spontaneously and quickly.